Special issue

BOOK OF ABSTRACT

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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University of Palermo, Italy
June, 15, 2022

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

The Editors:
Benedetto Di Paola (University of Palermo, Italy)
Shuhua An (California State University Long Beach, CA, US)

Content

Introduction

This Special Issue was born within the Conference 2022 CTRAS Conference "*New and old challenges to support ALL students' mathematics teaching and learning in inclusive, fairly and meaningful way*", aimed in responding to new and old to support mathematics teaching for ALL students in the inclusive, equitable and meaningful classroom.

The proposal to publish this abstracts book as a special issue of the *Quaderni di Ricerca in Didattica* was immediately accepted with enthusiasm and great interest by the entire Editorial Committee of the journal. The topics addressed during the CTRAS Conference organized by the University of Palermo and the papers that have been discussed are, in fact, interesting for many researchers in Mathematics Education and Mathematics teachers who read our journal.

As the covid-19 pandemic continues in various countries, math teachers are facing new challenges in student learning. Numerous instructional strategies have emerged to meet the diverse needs of students in math learning. Many research studies have been conducted to identify the effective classroom teaching practice in response to new challenges.
The 2022 CTRAS Conference shared and discussed current challenges and solutions in innovative teacher training programs, teaching strategies, and research practices that support ALL students' mathematics learning in inclusive, fair and meaningful ways.

We are sure that inputs offered, in a competent and exhaustive way, by all 2022 CTRAS Conference Authors will be interesting points of reference for future investigations on the same research themes in Mathematics Education.

The Editors:
Benedetto Di Paola (University of Palermo, Italy)
Shuhua An (California State University Long Beach, CA, US)

KEYNOTE TALK

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

Using STEM Moment to Meet Challenges in Pre-Service Teachers' STEM Learning

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Abstract. This presentation focuses on the challenges in STEM teaching and solutions for pre-service teachers' learning STEM integration in math methods courses. The innovative activity, STEM Moment, was designed and implemented to address the challenges. In this activity, the pre-service teachers participated in learning about STEM integration, developing, and integrating the STEM Moment activities with videos to demonstrate their understanding of STEM integration. The results showed that, overall, participants developed their knowledge, skills and readiness to integrate STEM into math classrooms.

TOPIC SESSION 1: RESEARCH INITIATIVES 1

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

Investigation on the Current Situation of Middle School Students' Mathematics Learning from the Perspective of Deep Learning

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Abstract.

Purpose: The purpose of this paper is to investigate the current situation of middle school students' mathematics learning by using the corresponded questionnaire which reflects students' deep learning and find appropricate strategies to help students improve their deep learning behaviors.

Design/methodology/approach: The study has used the questionnaire survey to assess 180 participants' deep learning situations, which incudes eight dimentions and forty-three questions. The eight dimetions are memory style, knowledge system, focus of attention, degree of dedication, self-reflection, migratory ability, thinking level and learning motivation which are cited from Zhang and Wu's study on deep learning.

Findings: This paper provides the findings that most students' mathematics learning is at a little above the medium level; The average score of each dimension is also at a little above the medium level, and there is a positive correlation between each dimension and between each dimension and the whole; Students of different grades have statistically significant differences but that of different gender.The study also shows that partipants had low scores in the three dimensions of self-reflection, thinking level and knowledge system.

Research limitations/implications: This study highlights the strateges of improving the levels of deep learning which includes paying attention to knowledge integration and improving cognitive structure, paying attention to high-order thinking and guiding critical innovation; developing reflective ability and setting learning goals.

Practical implications: In this paper, we realize that middle school students' deep learning situation is not very good and could help them to conduct deeping learning by using appropariate strategies.

Originality/value: The study is expected to provide reference value for middle school teachers to seek for effective strategies to promote students's deep learning and analytic basis for future research on deep classroom teaching.

"Quaderni di Ricerca in Didattica", Numero speciale n. 9, 2022
G.R.I.M. (Departimento di Matematica e Informatica, University of Palermo, Italy)

Students' Silences as Key in Assessing Mathematical Understanding: A Phenomenological Study

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Abstract. As the CoVid-19 pandemic hit the world, academic institutions all over the Philippines have had to shift from the usual in-person classes to modular or online distance learning. This transition brought about significant challenges to teachers, especially in reliably determining students' attainment of learning outcomes in mathematics. Foremost of these challenges is making sense of *students' silences* during online discussions, which has become an effective approach to determine how much have been understood from the day's lessons in real time. This study sought to determine how mathematics teachers interpreted and used the messages being sent by students using non-verbal cues such as virtual reactions in Google Meet, switching microphones and videos on and off, and chats as bases for assessing learning and responding to their students. In particular, it investigated the possible structures or formats of online mathematics discussions. A qualitative phenomenological research approach was employed in exploring the mathematics teachers' lived experiences while engaging students' in discussions and recitations. Data were collected through interviews, class video recordings, and online class observations and were analyzed using Colaizzi's method of data analysis. Findings revealed that students' silences in online mathematical discussions are a rich source of information and teachers could use them to determine accurately how much their students are learning each day. Recommendations include the need for mathematics teachers to listen to students' non-verbal cues and to be pro-active in reaching out to students' who choose to be silent in their classes.

Keywords: *assessment, discourse, non-verbal cues, online mathematical discussions, qualitative phenomenological study.*

Investigate Student-centered Orchestration with DGE From the Perspective of Technology-enhanced Mathematics Classroom Discourse

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Abstract. The instrumental approach (Drijvers & Trouche, 2008; Drijvers et al., 2010; Trouche, 2004; 2005) and classroom discourse perspective (Michaels & O'Connor, 2015; Ng et al., 2020) have been widely used in the research of teachers' teaching practices. On one hand, teachers have an important influence on the stimulation and formation of students' instrumental genesis, while previous studies pay little attention to the student-centered orchestration. On the other hand, classroom discourse has a great impact on students' mathematics learning, while seldom investigate it in a technology-rich classroom. Therefore, using the theory of instrumental approach and classroom discourse as the main framework, this proposal aims to investigate:

(1) What are the characteristics of student's instrumental genesis when using DGE and what types can they be classified into?

(2) How can we characterize teacher's instrumental orchestrations from the perspective of classroom discourse?

(3) How are instrumental orchestrations related to students' instrumental genesis in classroom discourse?

(4) How do teachers orchestrate students' use of DME through classroom discourse?

The study will recruit teacher participants and will adopt a qualitative method. Qualitative data (interviews, lesson videos) will be analyzed following the constant comparative method (Corbin & Strauss, 2008) with the lenses provided by the instrumental genesis, instrumental orchestration (Drijvers & Trouche, 2008; Drijvers et al., 2010; Trouche, 2004; 2005) and classroom discourse theory (Michaels & O'Connor, 2015; Ng et al., 2020). **Keywords:** instrumental orchestrations; instrumental genesis; Student-centered orchestration; technology-enhanced mathematics classroom discourse

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Teacher Intervention during Collaborative Problem Solving in Chinese Mathematics Classroom

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Abstract. In PISA 2015, students from four China mainland cities/provinces performed poorly in collaborative problem solving (CPS) compared to other subjects. In classrooms from China, students' collaboration was facilitated widely since 2001, however, the empirical research on the role and intervention of teachers was quite scarce. Influenced by the international and national tests, open-ended tasks are more widely developed and used during mathematic lessons, and they are seen as more suitable for CPS. In this paper, we firstly investigate the effect of teacher intervention during pair and group CPS by experiment on four teachers with eight classes. Then we select the typical cases of teachers and analysis the reason of effect mainly from the perspective of intervention focus and means. We found three of the four teachers' interventions are effective in the result of tasks. The most effective teacher and the no effective teacher are selected for the case study. We discuss the effect of teacher intervention that may come from emphasizing the social activities, pre-design the intervention, and maintenance of a consistent intervention style. Because the situation in the classroom in China and western are quite different in the authority of teachers, we then make several suggestions on implementing the teacher intervention: choosing an appropriate form of collaboration group and carefully implementing the intervention.

Keywords: *Collaborative Problem Solving, Teacher Intervention, Open-ended Tasks, Case study*

Improving Diverse Learners' Math Vocabulary Knowledge with the MALITLA Model

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Abstract. Culturally and linguistically diverse learners in the United States continue to experience difficulties in performing at expected mastery levels on standardized test data. One issue is related to encountering unknown math vocabulary words in problem solving test items. Seminal research indicates that English language proficiency is an important factor in predicting children's mathematic performance (Vokovic & Lesaux, 2013). Other work by Abedi and Lord (2002) indicated that when the burden of linguistic complexity was reduced for comprehending vocabulary math terms, students improved their ability to make better meaning of math terms for problem solving. The presentation discusses an innovative model referred to as MALITLA for improving culturally and linguistically diverse elementary school children's mathematical vocabulary knowledge. The model synthesizes theoretical works from linguistics, literacy, education, and mathematic pedagogy.

The presentation discusses the MALITLA components including: (1) Explicit instruction allowing for the gradual release of responsibility (Pearson & Gallagher, 1983); (2) Vocabulary building literacy strategies (LaBrocca & Morrow, 2016; McKeown & Beck, 2014); (3) Translanguaging math talk to promote cognition in math learning and meaning making (Garcia & Wei, 2014; Robertson & Graven, 2019) through discussion involving repetition, elaboration, and mathematical vocabulary usage (Banse, Palacios, Merritt, and Rimm-Kaufman, 2017; Huffered-Ackles Fuson & Sherin, 2004); and (4) authentic listening, speaking, reading, and writing mathematic activities (National Council of Teachers of Mathematics, 2000; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

Audience participants will have opportunities to provide feedback and pose questions to the presenters.

Reasoning and proving in Algebra. Examples from 8th grade school mathematics textbooks in Italy

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Abstract. Some research studies concerning the didactics of Algebra discuss how learning to solve problems using symbolic algebraic language can be hard for students (Bohlmann et al., 2014; Palm, 2009). Students, in fact, have often difficulty to learn the ways in which the symbols should be manipulated to argue or to prove an assertion in order to reach a problem solutions. Although many studies conducted by mathematics educators discussed important contributions to this subject (e.g. Arzarello, Robutti & Bazzini, 2005; Boero, 2001; Carraher, Schliemann, Brizuela & Earnest, 2006; Lins & Kaput, 2004; Ursini & Trigueros, 2001), not many analysis were conducted on the role of the School textbook in this complex teaching /learning context. The paper, focusing on this aspect, discuses some preliminary MaTeK (*Enhancement of Research Excellence in Mathematics Teacher Knowledge*) Horizon 2020 project results, related to the analysis of some algebraic reasoning and proving tasks, discussed in 8th grade school mathematics textbooks in Italy.

Acknowledgment

This abstract was supported by the H2020 project no. 951822, MaTeK. https://www.projectmatek.eu/. We would like to express our special thanks to our colleagues in the project: Işıl İşler Baykal, Erdinç Çakıroğlu, Iveta Kohanová and Jakub Michal

TOPIC SESSION 2: RESEARCH INITIATIVES 2

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

The Role of Moore's Interactions in Learning Mathematics through Modular Distance Learning

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Abstract. Interaction is a vital component of a meaningful learning experience. Moore (1989) suggested that there are three types of interaction in a distance learning environment. These interactions are categorized as learner-instructor, learner-content, and learner-learner. The pandemic brought significant changes in how teachers deliver mathematics instruction. Consequently, it minimized the amount of interaction among the key participants of learning. In most cases, teachers utilized the modular approach in teaching their students (learner-content interaction). Hence, learner-instructor and learner-learner interactions were not included. There is diversity in how the students learn and not everyone learns by just reading or interacting with the learning content. Other students learn mathematics by interacting and solving problems with their peers. Similarly, students also need teacher support especially in learning the key concepts. For mathematics learning to work in a distance learning setup, these two interactions should be considered. In this proposal, these interactions shall be discussed; focusing on their role and importance in the teaching and learning process and their implications to mathematics education. Additionally, possible solutions will also be explored to address the non-inclusion of these interactions in a modular approach for a more holistic learning experience.

The number of primary and secondary school students with the characteristics of a sense of the law of development and its teaching design

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Abstract. In this study, based on the current number of primary school mathematics curriculum content and implementation of a sense of the reality of four selected primary schools of different levels of two to nearly 700 students in sixth grade, the number of samples for the study a sense of elements of the test, and interviews of some students . Through statistical analysis of test results, obtained the number of primary and secondary school students with a sense of the characteristics of the development of the law, summed up the development of primary and secondary school students stage a number of flu. And primary school mathematics curriculum and teaching materials, as well as building a sense of culture proposed by a number of valuable suggestions.

Keywords: *Number Sense; courses,； primary and secondary school students*

Integrating Social Emotional Learning with the Mathematical Practice Standards

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Abstract. Today's teachers are facing new challenges in mathematics education: the task of providing a positive and nurturing classroom environment for students who have had adverse childhood experiences. One solution to this problem is for teachers to incorporate Social-Emotional Learning strategies to teach students important life skills, help them develop a positive self-image, take responsibility for their actions, and build positive relationships with others.

In this presentation, I will introduce what SEL is (e.g., building interpersonal and intrapersonal skills) and the benefits of SEL (e.g., fosters a growth mindset, builds confidence, and increases interest in math). I will introduce the 5 Core Competencies of SEL (e.g., Self-Awareness, Self-Management, Social Awareness, Responsible Decision-Making, and Relationship Skills) and explain what math educators can do to build these competencies in their students. I will demonstrate how the 5 Core Competencies of SEL are related to the 8 Mathematical Practice Standards. For example, with MP3: Construct viable arguments and critique the reasoning of others, students listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments. This builds students' Social Awareness by helping them understand others' perspectives to effectively interpret their arguments and builds Relationship Skills by asking students to listen actively to further explore the arguments of others.

I will share this information through an interactive Nearpod presentation. I use this tool in my classroom frequently to keep students actively engaged. The interactive slides include drawing slides, matching slides, open-ended questions, quiz questions, and a fun Time to Climb game-like competition.

The history of mathematics as a key to intercultural inclusion in classroom teaching practice

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Abstract. The research on the intercultural phenomenon in Italy increased with the growing phenomenon of migration, highlighting the problem of cultural diversity and social policies. The school has, in this process, a key role. The goal of a good educational project is to understand that the intercultural requires continual reference to the concrete experiences of the people. Theoretical assumptions of our project are the concepts of "interaction", "empathy", "decentralization" and "cognitive transitivity". In this theoretical direction, we present an experimental multidisciplinary mathematical laboratory where students and teachers can understand that a discipline that seems static and rigid is the result of an evolution involving different peoples, with very different, often conflicting, traditions and religions. Multi-ethnicity, which increasingly characterizes our society, is surely an important opportunity of growth and enrichment for people. We want to show the steps of the project, the results of our work and the positive effects in terms of intercultural education, aimed at opening up new horizons of teaching / learning towards past historical realities in teachers and students.

The adverse effects of systematic proceduralization on mathematics education reform

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Abstract. One of the goals of international mathematics education reform efforts is improving the quality and quantity of mathematics education for all students. For example, the mantra "Mathematics for All!" is used frequently at international conferences and in top-tier publications. Foundational mathematics education reform documents describe the importance of high-quality, demanding, rigorous, challenging mathematics education curricula for all students. My research study investigates the role of educational bureaucracy in the mathematics education reform movement. Specifically, I coordinate various theoretical perspectives (including complexity theory, Dewey and Schon's concept of meaningful practitioner reflection, and the systemic proceduralization of pedagogy) to argue that the increasing bureaucratic load on education significantly undermines reform efforts, especially for the most marginalized and vulnerable of student populations. I examine various failures in the contemporary mathematics education reform movement, and I develop theory delineating how entrenched educational bureaucracy over-extends normal cultural flows toward proceduralization—to ultimately impede meaningful reform. Bureaucratic committee meeting solutions discussed around the conference table often sound good to those present but in reality have awful practical implications that set back reform efforts. After giving specific examples of reform attempts being derailed by bureaucracy, I recommend standardization must be kept in the realm of idealization, to avoid the dehumanizing trend of quantify complex human behavior.

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TOPIC SESSION 3: TRAINING TEACHERS EDUCATION RESEARCH

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

Comparison of math teachers' noticing between in-service and pre-service teachers: a study based on mathematics teachers online exemplary lessons

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Abstract. Teacher noticing is regarded as a desirable ability in mathematics teachers' expertise in teaching. Existing research about teacher noticing mainly focus on pre-service teachers (PSTs) and relatively less on in-service teachers, rather less on the comparison between these two groups.

In this study, we applied two noticing frameworks, which are Learning to Notice and FOCUS Framework adapting from Three-Point Framework. Two teacher groups were invited to join this study. One is twenty in-service primary teachers with teaching experience ranged from 3 months to 27 years, another is seventeen pre-service teachers who are also year three students majoring in math education. They were asked to observe online exemplary primary mathematics taught by expert teachers, and provide their observing outcome by filling an online survey based on one noticing framework.

We used two coding methods to distinguish the feature of what and how teachers notice. One method was concerning agent, topic and stance; another concerned the four levels of noticing. Interestingly, pre-service teachers and in-service teachers showed a lot of similar characteristics. Both groups mainly noticed students' mathematical thinking and teachers' teaching pedagogies, which are two central elements of a lesson. While both teachers had noticing levels in baseline and mixed, higher proportion of in-service teachers had mixed noticing level compared to pre- service teachers. Besides, Higher-level of teacher noticing were mostly found among teachers with more than 19 years of teaching experience.

The Construction of a Framework for Measuring Students' Mathematical Creativity in Conjecturing-Based Teaching

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Abstract. Creativity is one of the basic 21st century cognitive skills that determine career readiness. Creativity for all students to be promoted in classrooms has been become as one of the goals of school education. The issues of teaching for creativity to be addressed includes: what is the definition of creativity to be operated in classroom teaching? what is the critical features required in a task for eliciting mathematical creativity? How to measure students' mathematical creativity which performed in classroom teaching? The study aimed to develop a framework for measuring mathematical creativity for all students engaging in conjecturing tasks implemented in mathematics teaching. The four components of creativity in the framework consisted of fluency, flexibility, originality, and elaboration. The conjecturing tasks in the study offered students the opportunity to discover the mathematical relationships in different ways via looking for patterns based on observing cases The truth of a mathematical relationship merely relying on finite cases is uncertain until it is justified, thus the relationship is called a conjecture before it is justified. The numbers of, category, novelty, truth of a conjectures correspond to the indicators of the fluency, flexibility, originality, and elaboration, respectively. A conjecturing task is featured as open-start combining with open-ended, high cognitive demands, and mathematical challenge. The challenge is the difficulty that a person is able and motivated to overcome at a moment. The rubric of each component in the framework is adapted from Leikin's (2009) model of 10-1-0.1. The elaboration was not concluded in Leikin's model, but it was included in the framework of the study. The tasks used in this study were the conjecturing-based, but Leikin's tasks were problem- based. One's flexibility scores is 21.3 means that one made 2 conjectures in distinct categories and accepted as group-conjectures, 1 conjecture in the same category with unlikely, and 3 conjectures that repeated previous ones. The detail of the framework for measuring mathematical creativity in classrooms will be reported in the conference.

The Socio-Analytic Dimension of Mathematics as an Imperative: Designing a Pre-service Secondary Mathematics Teachers' Education Course for Critical Citizenship

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Abstract. History has shown that problems of social order, or the resistance to measures from authorities, and the emergence of open conflict, arise out of difficulties like environmental disasters, plagues and pandemics. In the Philippines, the emergence of the COVID-19 pandemic highlighted some problems of social order that could no longer be left alone for only authorities to resolve. Media accounts revealed ineffective management of the pandemic, breach of protocols, worsening violence and impunity, coercive civil measures, consolidation of executive powers, and rampant social media- borne misinformation. In the light of the pervading social-order problems, we questioned how mathematics could become an instrument in developing students' understanding of the social degradation that is happening to the world. Drawing on online ethnographic practitioner research approach, this study employed both quantitative and qualitative data-gathering methods. Ten to 15 volunteer PSMTs in a Philippine university were purposively invited to attend a researcher-designed course that uses mathematics as a tool to help address social-order problems. The aim of the study was to investigate how critical mathematics education could address the tension between the need for students to be mathematically proficient and to develop critical citizenship through end-of-lesson group tasks, whole-class discussions, individual reflections and group project making that resonate creative problem-solving and dialogic pedagogies.

Developing Pre-service Mathematics Teachers' Lesson Evaluation Skills Through Online Lesson Study

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Abstract.

Introduction
Switching to fully online learning mode due to the COVID-19 pandemic has posed great challenges to mathematics teacher education courses, especially those empirical learning activities that conventionally require on-site, face-to-face interactions, such as observing and evaluating mathematics lessons. It is imperative to explore new ways in virtual settings to improve the effectiveness of lessons that intend to develop mathematics teaching skills among pre-service teachers.

Purpose and research questions
We designed a new instructional approach for Mathematics Pedagogy which incorporates online Lesson Study (LS) activities that specifically focus on developing pre-service teachers' skills in evaluating mathematics lessons. A collaborative group of mathematics teacher educators, researchers, and pre-service and practicing teachers are involved. Through these LS and research activities, we attempt to investigate the following two research questions:
How do online LS activities influence university mathematics teacher educators' instructional practices?
How do online LS activities help pre-service teachers improve their understandings of mathematics education theories and classroom teaching and improve their skills in evaluating the qualities of mathematics lessons?

Theoretical backgrounds
Members of the LS group build a community of practice through a set of shared, mutually explicit practices and beliefs, as well as an understanding of the long-term pursuit of common interests (Wenger. E., 1998). It is a collaborative learning cycle based on teams and led by teachers, aiming at improving teachers' mastery of subject content knowledge and teaching knowledge and exploring the professional relationship among teachers (Huang R., Takahashi A., da Ponte J.P., 2019). The LS activities could potentially help pre-services teachers understand teaching methods, cultivate their insights and abilities, strengthen their sense of collaboration (Gurl T., 2011).

Method
Our LS group includes two experienced university mathematics education faculty members, two mathematics teachers with rich teaching experiences, two mathematics education graduate students, and a university instructor who coordinates pre-service teachers' teaching practice activities as well as taught the LS lessons. The students involved in the LS lessons are 60 pre-service teachers in their sophomore years with no prior teaching experiences.
There were three online LS lessons and three corresponding post-lesson reflective activities. The LS group collaboratively planned and discussed each lesson. When the university instructor taught each

lesson, other members of the LS group observed. After each lesson, the instructor reflected on the implementation and other members made comments and suggestions. All activities were carried out via Tencent Meeting, QQ, and WeChat.
Pre- and post-LS surveys were administered among pre-service teachers and analyzed quantitatively to measure their understanding of lesson evaluation as well as differences before and after the LS activities. Six pre-service teacher volunteers were chosen for a semi-structured interview on mathematics lesson evaluation. The interview transcripts were coded for main themes to emerge. Video recordings of the LS lessons and reflective activities were also coded by the researchers and major themes were summarized.

Results

Through the LS activities, the mathematics teacher educator was able to discover the gap between the expected and actual skills of pre-service teachers in evaluating lessons, revised future lessons accordingly, and monitoring students' skill development continuously. He changed his teaching method from simply playing teaching videos and explaining existing criteria for lesson evaluation to demonstrating and modeling high quality lesson evaluation activities, facilitating pre-service teachers in exploring and generating a set of evaluation criteria on their own. His instructional mode also expanded from lecturing to including group and whole class discussions, sharing, and comments. Throughout the process, the teacher educator was also able to strengthen his own understanding of theories and research relevant to mathematics teacher education and development.
For pre-service teachers, the LS activities helped them switch from passively accepting information provided by the instructor to increasingly and actively participating in discussions and expressing their own ideas and opinions. They feel more comfortable and productive in collaborating with group members and sharing with the whole class through instant messaging apps and virtual meeting software. With the opportunities afforded by the online technologies, they were able to replay and reexamine all video recordings, conducting more thorough analysis of related lessons and reviewing prior discussions. As the result, they were able to quickly deepen their understanding of the main elements of classroom teaching, and apply such understanding to generate a more comprehensive framework for evaluating mathematics lessons.

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Pre-Service Teachers' Knowledge on Math and Health Integration

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Abstract. This study addressed how to develop pre-service teachers' interdisciplinary knowledge by integrating math and health into children's math and health literature books. The data was collected from more than 600 pre-service teachers' work in three years. The study analyzed pre-service teachers' interdisciplinary knowledge demonstrated in designing children math and health literature books in four main areas of health and math integration: (1) selection of CCSSM content and math practice standards, (2) selection of health standards, (3) design of themes in real-world applications, and (4) design of worksheets in math and health integration. Findings show that the pre-service teachers' knowledge on integration not only focused on the major health topics, like nutrition, but also on promoting children's social emotional learning in growing their capacities in CCSS Mathematical Practice.

Teacher Education via A mooc on assistive technology for students with visual impairment

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Abstract. Accessing mathematical semiotic resources, such as formulas, tables, and graphs, is not merely a challenge for people with Visual Impairments (VI) (Ahmetovic *et al*., 2019), but it is an open problem in the field of Inclusive Mathematics Education. Our research focuses on teachers' professional development. In particular, we provide them with some assistive technologies and teaching strategies for the inclusion of students with VI in mathematics classrooms in regular educational institutions. The data come from a MOOC (Massive Open Online Course) delivered on a Moodle platform. The design of the MOOC is based on TPACK theory (as in Niess, 2006). We focus on teachers' discussion, via suitably organised Moodle forums, concerning classroom interactions (as in Moura, 2020) where students with VI use assistive technologies (e.g., the markup language LaTeX, or the sonification of graphs). We also analyse the design of a classroom teaching activity, which each teacher based on the professional development they received. The study involves 70 participants, including mathematics and support teachers. Our approach is qualitative, combining the Dialogical Interaction Pattern (Moura, 2020) with the Inclusive Landscapes of Investigation perspective. This allows to answer our research question: How do teachers manage to develop classroom teaching activities, using MOOC resources, in order to provide teaching for students with VI at the same level as their peers, both in terms of contents and of interaction about such content? The results suggest that mathematics assistive technology is key. This has two consequences. Firstly, unlike the ordinary de facto situation, the support teacher really can now contribute to the learning of all students. Secondly, the autonomous participation of students with VI pivots on the sharing and negotiating of semiotic resources and didactic tools. Therefore, assistive technology has the semiotic potential to bridge direct student-student, mathematics teacher-student, and task-student interactions, rather than relying essentially on the mediation of the support teacher. Further results will be detailed in the presentation.

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TOPIC SESSION 4: INNOVATIVE TEACHING PRACTICES RESEARCH 1

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

"Quaderni di Ricerca in Didattica", Numero speciale n. 9, 2022
G.R.I.M. (Departimento di Matematica e Informatica, University of Palermo, Italy)

An Empirical Research on the Mathematical Cultural Connotation of Mathematical Writing

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Abstract. Mathematical writing is a significant method to evaluate mathematical homework, and an important research tool to reflect the consistency of teaching-learning-evaluation in lesson study of mathematical culture. Under the connotative analysis framework of mathematics culture based on the history of mathematics, qualitative research method was adopted to carries out empirical research on the mathematics writing of 60 students in 2 classes based on text analysis method in 2 lesson studies of mathematical culture including concept of functions and area of circle. It was found that there are five connotations of mathematical culture in mathematical writing, which mainly represented the sources of knowledge, entertainment of aesthetics and multiculturalism, while the representation of connection of disciplines and role in society were relatively inadequate. Mathematics writing also revealed six dimensions of the educational values of the history of mathematics: the harmony of knowledge, the beauty of ideas or methods, the pleasure of inquiries, the improvement of capabilities, the charm of cultures, and the availability of moral education (Wang et al., 2017). Mathematics writing effectively cultivate students' *Four Basics* and *Four Abilities* (Ministry of Education 2017). In the future, the professional learning community need to strengthen writing guidance to optimize mathematical writing, inherit mathematical culture to cultivate core mathematical literacy, strengthen the empirical research to implement the consistency of teaching-learning-evaluation.

Keywords: mathematical writing; mathematical culture; lesson study; concept of functions; area of circle; consistency of teaching-learning-evaluation

Notes:

(1) ***Four Basics.*** Students should obtain basic knowledge, basic skills, basic ideas and basic experience through mathematics activities, which are necessary for future study and personal growth.

(2) ***Four Abilities.*** Students should enhance their abilities to both find and pose problems mathematically, and also to analyze and solve mathematical problems.

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"Quaderni di Ricerca in Didattica", Numero speciale n. 9, 2022
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A Content Analysis of the Mathematics Assessment Tasks in the Secondary Level of the Philippine Distance Learning

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Abstract. Schools worldwide committed to delivering education amidst the pandemic transitioned from traditional face-to-face classes to remote or distance learning. Mathematics education is seen as challenging in a typical setting, and with this leap in learning modality, mathematics teachers must anticipate many modality-driven issues. Several studies on effective strategies and technologies, teacher and student perspectives, and challenges of mathematics education on distance learning were conducted, attempting to address the added difficulty of the current educational setup. However, research on mathematics learning assessment seems to be lagging. As one of the crucial parts of mathematics education, assessment is expected to struggle in distance education as time, authenticity, and feedback are under a minimal control of the teacher. This conflict may be seen as a limitation to assessments, yet it might be an avenue to the new and creative design of assessment tasks beyond these intervening variables. Thus, the researcher is interested in answering the following questions: (1) What are the different types of mathematics assessment tasks used by secondary mathematics teachers in distance learning? (2) What content and cognitive domains are covered by the assessment tasks? (3) What are the different innate assessment standards set by the mathematics teachers in constructing the tasks? This research will meet these objectives using interviews and content analysis of the class modules, online classrooms, or portfolios through the lens of the 2019 TIMMS Assessment Framework and the National Research Council's (NRC) assessment triangle. Hopefully, this study will encourage mathematics teachers to construct tasks that will help diversify assessments across contexts during and post-pandemic education and later motivate researchers to create a framework for mathematics assessment in distance learning.

Differentiating Instruction for ALL Students in a Seventh Grade Math Class

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Abstract. Demographic changes across the nation have led to the creation of classrooms with students of many different backgrounds, experiences, mathematical abilities, and attitudes towards learning. A recent report from the US National Centre for Education Statistics (NCES) shows that, student populations in U.S. public schools have become more diverse since 1990 (Snyder & Dillow, 2012). At the same time there is an increased demand for more accountability in U.S. schools. Teachers are being asked to meet the educational needs of all students. Teachers need to find a way to meet the needs of a broader range of students with varied and rich activities. When a teacher differentiates instruction, they use the best teaching practices and strategies to create different pathways that respond to the needs of diverse learners. This approach benefits students in multiple ways: finding success with engaging, meaningful tasks; seeing themselves as competent in math; and having fun while learning math.

This presentation describes a project where a mathematics teacher designed and implemented a variety of differentiated instruction activities into his seventh grade mathematics curriculum. The focus of the project was on the impact these activities had on two students: one who has a history of struggling and often requires remediation, and one above average learner who would benefit from planned enrichment activities. This presentation shares the challenges, successes and reflections of the teacher and reports on how teachers can differentiate to meet the needs of ALL students in their mathematics classes

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Differentiating Instruction for ALL Students in a Seventh Grade Math Class

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Abstract. Teaching the real-world application of solid geometry is always a challenge in mathematics education. Covid-19 pandemic has had devastating impacts on the field of education. However, Studying the cure for Covid can provide a great opportunity to teacher real-world application of mathematics, especially solid geometry. We propose to apply computational biochemistry on potential Covid treatment to teacher geometry, algebra and vectors. We propose to examine high-resolution crystal structures of SARS-CoV-2 nucleocapsid protein binding to small molecules (potential drugs). Protein structure is the three-dimensional arrangement of atoms in an amino acid-chain molecule. Protein 3D structure is a perfect example of teaching geometry as it contains different shapes, such as pentagon, hexagon, and tetrahedron. Protein 3D structure is also a perfect example of teaching algebra as every atom has its unique Cartesian coordinates. Real-world application of vector will be taught based on crystal structures. Concepts like distance between planes, dihedral angles (and a lot more) can be easily exemplified. All the above approaches can be easily done on free academic software. Meanwhile, basic programming and computer language will be learned if the students are interested in cartesian coordinate transformation. By applying biochemistry to study the cure of Covid-19 computationally, teachers are able to teach real-world applications of geometry and vectors, interdisciplinary science, and social-cultural impact of pandemic in education.

"Quaderni di Ricerca in Didattica", Numero speciale n. 9, 2022
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Visualise, draw and write operations on Eastern and Western abacus in primary education

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Abstract. Abacus is the expression of human ability to count and, at the same time, one of the first mathematical tools developed by human beings. There are several kinds of abacus that witness the burden of cultural heritage. On one hand we focused on the Western abacus and its various sub-groups, like Russian or nine-bead and ten-bead ones, in which each bead counts as one; on the other hand, on the Chinese and Japanese ones, in which beads have different values. In all of them there is a strong connection with finger-counting; in particular in the Eastern abacus one of the most interesting features from the didactical point of view, is the huge role of invention, understanding and use of the 5-value bead. We used the theoretical framework of Cultural Transposition to value the differences and analogies between these various cultural-counting-artefacts and their classroom worth. The paper presents a didactical experience with 60 primary-school students (7-11 years) involved in simple computations using different abacus. According to the Chinese Variational didactical approach each artefact (Western, Chinese and Japanese abacus) was used to solve each type of issue (addition and subtraction) using one tool at a time, with the aim to favour a comparison between tools and tasks. With this purpose we asked students to show on sheet the whole operations, and not just the result (sum or difference). In the paper we discuss the quantitative and qualitative findings about the behaviours of pupils in the process of visualisation and drawing of their learning paths.

TOPIC SESSION 5: INNOVATIVE TEACHING PRACTICES RESEARCH 2

2022 CTRAS CONFERENCE

NEW AND OLD CHALLENGES TO SUPPORT ALL STUDENTS' MATHEMATICS TEACHING AND LEARNING IN INCLUSIVE, FAIRLY AND MEANINGFUL WAY

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UNIVERSITY OF PALERMO, ITALY

JUNE, 15, 2022

Supplementing Printed Modular Distance Learning with Teacher-Made Video-Based Learning Materials in Algebra

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Abstract. This action research aims to develop, validate and implement Video-Based Learning Materials (VBLM) to supplement learning about quadratic equations under modular distance learning. More specifically, the study identified the challenges encountered by the students in learning math content and used this information to develop VBLM. It also investigated how the VBLM helped students understand the lesson's content. Participants of this study were twelve (12) grade 9 students from one class whose previous mathematics teachers qualitatively identified them as struggling learners in math. The study utilized the Action Research design following the Plan-Do-Study-Act (PDSA) model. Thematic analysis was used to analyze qualitative data from a focused group discussion with the parents and interviews with the students. Results revealed that challenges of the students in learning math content are lack of additional learning support, insufficient background in math, and content of the SLM. The design and development of the VBLM followed Mayer's 12 Principles of Multimedia Learning and the data about the students' needs. Quantitative data from the evaluation of the experts and students showed a highly favorable rating of the VBLM. The result also revealed that the VBLM helped the students learn math in ways such as (1) providing clear and adequate examples, (2) being easy to follow, and (3) promoting independence. The findings of this action research may be significant to teachers wanting to develop their video lessons to improve the lesson delivery.

Key Words: video lesson; distance learning; challenges in learning math; multimedia learning; supplementary learning

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Is it a Square? or a Rhombus? Or a Rectangle?

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Abstract. Square? Rhombus? Or Rectangle? This is a very common phenomenon when teaching how to discern between square, rhombus, rectangle or parallelogram. This abstract demonstrates how patterns of variation are employed from the Theory of variations to help consolidate students' geometric understanding and mathematical reasoning. The central idea of classifying different kinds of quadrilaterals is to *discern* the critical aspects among different quadrilaterals. The spirit of *discernment* includes how to support variation and interactions reciprocally which becomes a kind of mathematical pedagogy and develops a discourse analysis in a mathematics classroom.

The abstract demonstrates how a teacher makes a discernment of critical features of the geometrical objects through a systematic variation and interaction in a mathematics classroom. Good mathematics teaching should construct a space for students to discern the variants and the invariants in order to make a generalization of a phenomenon. Subsequently is to develop students with an ability to generalize, classify, categorize, symbolize, and even axiomatize and operationalize of certain patterns or phenomenons.

"Quaderni di Ricerca in Didattica", Numero speciale n. 9, 2022
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Enhancing Mathematical Creativity for Primary Gifted Students Through Creativity-Directed Tasks Incorporated into Conjecturing Teaching

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Abstract. This study was designed to compare the difference and similarity in creativity when fourth- and sixth-grade gifted students engaged in creativity-directed tasks in mathematical conjecturing teaching. Two classes of fourth-grade and sixth-grade gifted students were the subjects of the study. They were taught by a same prospective teacher who majors in special education and mathematics education. The creativity-oriented tasks and the instructor were the two control variables of this study. The tasks used in teaching, students' worksheets, and video- with audio-tapes of teaching were the main data collected for the study. The number, categories, novelty, and generalization of the conjectures that students generated in the conjecturing teaching were analyzed as the indicators of fluency, flexibility, originality, and elaboration of the creativity, respectively. The rubrics of each component of the creativity was adopted from Lin's framework of measuring students' creativity (Lin, 2020).

The results of the study included two parts. One is with respect to designing creativity-oriented tasks and the norms of conjecturing teaching for creativity. What the principles of designing creativity-directed mathematical conjecturing tasks for sixth-grade and fourth-grade- gifted students needed to be considered in similarity and difference. Additionally, different teaching strategies can foster students' creativity through free-wheeling, mind mapping, and criticism is ruled out after comparing the students' conjectures with different unit. The other part is to describe the two age-groups' of primary gifted students performing in fluency, flexibility, originality, and elaboration. Finally, this research provides suggestions to the creativity-directed mathematical conjecturing teaching instructors and future research directions. The methodology and the results conducted in the study will be reported in detail in the coming CTRAS international conference.

Data-driven-Learning: Student-focused Teaching for Learners' Engagement and Performance in Challenging Times

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Abstract. In our modern academic world, much more data are being collected on students than ever before. The rapid technological changes create new chances for educators and students to track their achievements and collect data about educational progress (Ifenthaler, 2017; Rajaram, 2021). The large quantity of data being collected forces teachers and faculty staff to think about questions like "How can the data be effectively used to improve the existing curriculum?" and "What can be learned from the data that we have collected?" and "What are the advantages for the learners?" (Parrish/Richman, 2018). These tracking activities can be defined as learning analytics. It is the measurement, collection, analysis, and reporting of data about learners and their contexts, for understanding and improving learning and the environments in which it occurs (Siemens, 2013). *Effective usage of learning analytics helps understand the learning patterns, social and motivational aspects to enhance the students' learning outcomes. Learning analytics is used to predict students' learning process and its intended outcomes providing faculty the feedback towards supporting their academic achievement* (Ifenthaler, 2017; Rajaram, 2021). In this session, different educators will present evidence-based showcases dealing with the mentioned challenges in the classroom (e.g. in mathematics courses) and explain how learning analytics can be used effectively for learners and teachers (e.g. in the MINT field).

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STEEM prevents a goal-displacement that makes mathematics a goal instead of a means

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Abstract. Asking what is the purpose of mathematics education, US and UK mathematics educators say "to learn school mathematics". Others say "to learn set-based mathematics as defined by university mathematics." Focusing on competences leads to saying "to learn mathematical competences" or "to master mathematics". Seldom, if ever, is heard that the goal is "to master many" or "to develop the number-language that children bring to school."

Sociological imagination (Bauman, 1990) may prevent a goal displacement where a means becomes a goal instead. Historically, the Pythagoreans chose the word 'mathematics' meaning 'knowledge' in Greek as a common name for their knowledge about Many in space and time and by itself: astronomy, music, geometry and arithmetic. And today in North America, mathematics is still a common name for geometry and algebra, showing their outside goals in their original meanings, earth-measuring in Greek, and reuniting in Arabic. Integration and differentiation also name their tasks directly, to integrate small changes, and to differentiate a total change in small changes.

Including economics in STEM, STEEM allows core mathematics to be learned by trading bundles, e.g., 2 3s = ? 4. This will avoid a goal displacement by de-modelling mathematics (Tarp, 2019) in its core ingredients: digits, operations, equations, fractions, functions etc. to allow primary school develop the flexible bundle-numbers children bring to school by teaching, not numbers to add, but numbering totals by counting, recounting and double-counting, where recounting 8 fingers in 2s as 8 = (8/2)*2 leads directly to the recount-formula *T = (T/B)*B* with per-numbers that solve equations, that occur in most STEM-formulas typically predicting proportionality, and that become fractions when double-counting in the same unit.

Liberated from its goal displacement, mathematics education may have its own communicative turn as in the 1970s (Widdowson, 1978) such that from now on both the word- and the number-language are taught and learned through their use and not through their grammar, thus allowing all students to model outside quantities as to levels, change and distribution.

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