8TH ANNUAL RESEARCH MEET

March 6th- 8th 2018

Book of Abstracts

Homi Bhabha Centre for Science Education

Tata Institute of Fundamental Research

Mumbai

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Introduction

The Annual Research Meeting of the HBCSE is our centre's forum for discussion of research results and ideas. The ARM has two main objectives - sharing your work and thoughts, and seeking feedback from the HBCSE community for improvements.

This year, along with research scholars and scientific staff from HBCSE, we welcome PhD students from, the Department of Education of the University of Mumbai, to share their work with us.

The three-day long event includes 19 presentations on a wide variety of topics. We hope the event stimulates new ideas among its participants, leads to creative engagement with existing topics, and generates opportunities for fruitful collaboration.

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Abstracts

Error detection and design negotiation in Kashmiri carpet weaving

Dr. Gagan Deep Kaur
Discussant: Prof. Jyotsana Vijapurkar

I am a Homi Bhabha Fellow, studying situated and distributed cognitive processes in Kashmiri carpet weaving. For this, I have conducted 21-month long fieldwork in Srinagar, Kashmir, from 2015 to 2017 (likely to resume later this year).

This talk discusses the findings obtained to preliminary data analysis on error-detection strategies adopted by actors in different stages of a Kashmiri carpet-weaving and revealing of an unexpected correcting agent, namely *rafugar* in the practice. The practice constitutes of three stages: design phase, wherein design is created on graphs (in manual-setting); coding phase, in which designed graphs are coded in practice specific symbols and weaving phase, in which the coded script, the talim, is decoded by the weavers to weave the design. Two sorts of errors generally creep in the process: *design* and *structural* errors. The design errors relate to mis-drawing of the motif, missing or mis representing of color-codes by designers in the motifs. These errors can be detected and corrected by code writers during coding: expert coders were found to correct motifs (to a certain extent), fill-in missing codes and correcting the wrong codes written by the designers. This is the first stage of error-detection and correction in the practice. However, the coded script still may include errors, which creep in due to: miscalculation and consequent miswriting of knot-cells, miswriting of colour information or inadvertent skipping of an entire row by the coder. The weavers were found to detect all these errors and correct, which brings in second stage of error-detection and correction. For correction, the weavers employ design inference: the design pertaining to the column is matched with the previous row on the loom and prospective trajectory of motifs is inferred and error is corrected accordingly. The creative intervention by non-expert weavers however may spawn design errors, at times though. Besides design errors crept during weaving, there is an error that creeps up during weaving stage only: the *structural* error, which relates to tampering of the carpet structure, e.g. shortening of carpet height. At this juncture, the role of an unexpected actor got disclosed, i.e. the *rafugar*, which brings us to our third stage of error-detection and correction. The rafugar was found not only to detect minute design errors pertaining to orientation of motifs, misweaving of colours, shortening or increasing of the carpet height, but also correct these errors *on a woven carpet* through skilful knots extraction and re-insertion. Cognitive ethnography has been instrumental in revealing the *presence* of this actor in the practice, who is, however, non-regular in the practice. The eventual design, after it has passed these error-corrections by the above actors, can be said to be negotiated in character. This explains why the discrepancy of 10% accrues from initial conception of the design by the designer to its final emergence on the carpet, but it also shows how this discrepancy can be reduced to bare minimum: if actors in earlier stages can induce errors, then actors in later stages can detect and correct them anytime: even after carpet has been completely woven and taken off the loom, error correction can be done.

Connecting Mathematics in Representations: Teaching Multiplication and Division of Fractions

Shweta Shripad Naik
Discussant: Dr. Aaloka Kanhere

Shweta is a Mathematics Education Researcher interested in the problem of knowledge and practices needed for effective instruction.

This article reports on an analysis of 14 in-service secondary teachers' use of representations for teaching multiplication and division of fractions. For introducing fractions multiplication and division, the teachers built upon representations given in the Maharashtra state and NCERT textbooks. While doing so they form mathematical explanations around these representations so that students can make sense of algorithms involved in these operations on fractions. It is observed that the teachers knew procedures for multiplying and dividing the two fractions, however, how do these procedures connect with the representations remained unclear throughout the instruction. The dynamism within the representation of multiplication of fractions was conjectured as repeated addition, creating conflicting conclusions for multiplication of two fractions. With representations for the division of fractions, both partitive and quotitive explanations were built. However, identifying situations that distinctly carry quotitive meanings was absent and therefore partitive meaning was used prevalently, again confounding the understanding of division of fractions.

Ma (1999) illustrated that inadequate understanding of the procedure impedes designing of representations. Here, the teachers in the study showed confident knowledge of procedures and used ready-made representation, although created flawed explanations for the representations. Digging deep into the teachers' mathematical explanations around the representations, their meaning-making of students' responses and choice of teaching trajectory or examples indicate that making sense of dynamism within representations and seeing its parallel in the algorithm requires a kind of mathematical inquiry that is external to school mathematics. The presentation and paper describe this mathematical inquiry in detail.

Keywords: *Fractions Multiplication, Fractions Division, Representations, Mathematical Explanations*

References:

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Mahwah, NJ: Lawrence Erlbaum Associates.

Theories Pass, the Frog Remains: A Foray into the Philosophy of Biology

Charudatta Navare
Discussant: Chaitanya Ursekar

Charudatta is a research scholar at HBCSE. He is interested in studying the visual culture and the visual rhetoric of biology. A few of the things he's obsessed with include: comics, Second World War, and evolution and puns.

I will start with a brief overview of the philosophy of biology. I will delineate three strands in the philosophy of biology (a) Questions of the philosophy of science in the context of biology (e.g. the nature of explanations for human behaviour, or the conceptualization of an organism or environment as a system). (b) Theoretical questions and puzzles in biology (e.g. what is biological complexity? how to define reproductive fitness?). (c) Ways in which biological sciences can shed light on some of the traditional philosophical questions (e.g. the longstanding debates on nature versus nurture, or on the definition of life). I will explore particular philosophical issues relevant to taxonomy, evolutionary biology, ecology, molecular and developmental biology. I will then talk about the ways in which this discussion can be relevant for education in general, as well as biology education in particular. I will also talk about the insights we can get from philosophy of biology which are relevant to the issues of society and environment with respect to science and technology (e.g. what does gender mean? what is a race? what does preserving environment mean? what implications does restoring species have for the environment?) I am hoping to generate some interesting discussion after the talk.

TO SEE A WORLD: USING MULTIPLE METAPHORS IN SCIENCE EDUCATION

Dr. Mashood K. K.
Discussant: Prof. Sugra Chunawala

Dr. Mashood K. K. is a faculty member at HBCSE

Metaphors play a crucial role in how we conceive and understand new concepts and ideas. Using insights from science education research on the teaching of energy, this article illustrates how the use of multiple metaphors can help present dry, abstract and complex science concepts to students in more lively, engaging and richer ways.

Global Citizenship through Service Learning

Priti Sivaramakrishnan
Discussant: Dr. Sybil Thomas

Priti is an Assistant Professor at St. Xavier's Institute of Education. She is currently pursuing PH.D from Department of Education Mumbai University.

This study aims to understand student teachers perception about global citizenship in relation to service learning. Global means relating to the whole world and citizenship means belonging to a country. A global citizen is one who wants to understand, act and contribute towards a better society. Global citizenship requires learners and individuals to contribute to a global cause. An effective way to contribute to the society would be through service learning. Service learning integrates community service with academic learning and increases the scope for students' civic engagement. Engagement in community service would require student teachers to be just in their actions and thoughts.

Limitations in paper-based textbooks and students' struggle with vectors

Durgaprasad Karnam
Discussant: Dr. Mashood K. K.

I am in my 4th year of PhD, working on new media interventions deriving from cognitive principles for learning abstract concepts like Vectors.

The topic of vectors is introduced in the higher secondary level (grade 11 and 12) in India in Physics and mathematics. There is a lot of direct and indirect evidence in the literature for the difficulties that the students face in understanding and using vectors. Our earlier textbook analysis of their limitations in presenting topics related to vectors raised a possibility that some of these limitations may be inherent in any paper-based curricular material. If these limitations were to be valid, we should find certain patterns in the students' modes of reasoning and conceptual understanding. We validate these limitations by looking at the reasoning patterns and conceptual understanding of two sets of students (a regular classroom group and an independent group of a few high performers) through a series of interactions in form of a test and individual interviews. The results strengthen our hypothesis that there is a link between the paper-based mode of presenting content and the difficulties faced by the students in the understanding of vectors.

What could Social theories of Disability mean for Critical Mathematics Education?

Rossi D'Souza
Discussant: Dr. Arindam Bose

Rossi is a PhD student in mathematics education focusing on disability studies and Ableism

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I attempt to integrate the social model of disability and studies in ableism to address the disability question in mathematics education. While disability is predominantly understood as a problem that exists within the body of a person, the social model of disability argues that it is society and social barriers that disable physically impaired people. Studies in Ableism shifts the discourse towards the notion of normalcy and ableist cultures, with the aim of rejecting the idea of ableness. In the context of mathematics teaching, the social would imply that in the absence of social barriers, a blind child would not be disabled. But this raises the question, "... disabled from what? From passing an exam or learning a body of mathematical knowledge?" And, wouldn't our understanding of "not being disabled" be shaped by our own concept of normality?
Turning towards teaching mathematics, one cannot avoid recognizing that mathematics education plays a significant role in socio-political processes by functioning as a gate keeper, thereby justifying inclusion/exclusion. And further, a concern for developing mathematics education in support of democracy, implies that the mathematics classrooms must also show aspects of democracy. But what could a democratic classroom mean when it includes blind and mentally challenged children studying alongside the so called gifted children along with an "expert" teacher in a society where mathematics plays a socio-political role? Summarizing these concerns with the question, "What could Social theories of Disability mean for Critical Mathematics Education?" I respond by drawing from filed observations that include a student and teacher's narrative along with students' responses to my mathematics teaching at a study centre for blind children in Mankhurd, Mumbai.

Mixed Methods Research to understand the Relationship between Bullying Attitude and Personality Traits among IX Standard Students of Government and Private S.S.C. School in Mumbai.

Nahida Mandviwala
Discussant: Dr. Sybil Thomas

I am working at Rizvi College of Education as an assistant professor. I continuously strive towards professional development.

Bullying has become a global behavioural problem due to the rising incidence of school violence. In India educators are beginning to accept the prevalence of bullying behaviour in schools. This study attempted to find reasons for bullying by exploring narratives given by participants having a favourable bullying attitude. The study was conducted in 2 phases, Quantitative-Correlation Phase and Qualitative-Narrative Phase. The first phase of the present study aimed to find standard IX students' attitude, studying in government and private SSC schools in Mumbai, towards bullying and ascertained its relationship with their personality traits. The participants of the study in this phase comprised of 120 Standard IX students. Students scoring high on the bullying attitude scale and the extroversion and neuroticism dimension of the personality trait scale, were selected as samples for the qualitative phase. The second phase explored stories of individual students who had a favourable attitude towards bulling. Tools for data collection include ready-made Questionnaires and interviews.

Key words: Bullying, Bullying Attitude, Personality, Narratives

Lessons from Teachers' Interviews: A Milestone in Participatory Action Research

Dr. Rohini Karandikar
Discussant: Shweta Naik

Rohini is currently a visiting fellow working on School Science Research and Development project

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A Participatory Action Research (PAR) project is being carried out with a nearby school as an intervention in the context of environmental science (EVS). In its first two years, the project involved collaboration between members of HBCSE and teachers of grades 3 and 4. The objectives, experiences and learning of these two years of the project have been reported recently (Deshmukh et al, 2018). At the end of two years, all the (five) participating teachers were interviewed to get feedback on the project. This presentation reports our learning from the teachers' responses. In the interviews, teachers reported changes in students' thinking, their classroom interactions and questioning through specific examples. More importantly, teachers reported changes in their own pedagogic strategies, including use of open-ended questions, inquiry based approach and their preparation for students' questions. These reported changes suggest that we may be headed in a favourable direction. Some teachers also mentioned that they initially had reservations about the worksheets being used in the projects but were now positive. We find that the worksheets do scaffold interaction and promote reading and writing. Teachers' response led us to revisit our previous worksheets, rework and modify them based on student and teacher feedback which eventually we want to develop into a resource booklet for teachers. Teachers also reported some challenging questions asked by the students which, e.g., suggest the ability of students to observe fine details of a picture/diagram and make varied linkages with the topic under discussion. Several hindrances (such as (time constraints), reported by the teachers as well as those faced by HBCSE members (regarding classroom management) raise some questions and provide directions in which we need to strengthen our work.

Development and use of worksheets with students to facilitate learning and assessment

Rupali Shinde, Trupti Adangale
Discussant: Prof. Savita Ladage

Trupti has a Master's degree in Environmental Sciences and Rupali in Biotechnology. It has been a couple of years for trupti and a year for rupali, since they joined HBCSE and are part of School Science Research and Development (SSRD) group. They both had an active participation in a collaborative research project, which enabled them to interact with primary and upper primary students and teachers. This entire process got them interested in Science Education Research.

In the Participatory Action Research (PAR) project, the School Science and Research and Development (SSRD) team of HBCSE has been working collaboratively with the teachers in a neighbouring school for the past three years to engage students in the subject Environmental Studies.

One aspect of our work has been the development of worksheets and their use in classrooms, both as teaching and assessment tools. The talk will present the various purposes that guided the development of these worksheets. Some of these purposes we explicitly pursue and other purposes that we are conscious of and reflect on in the development of worksheets.

We have focused on language development of students', emphasis on drawings, linking the textbook content to daily life experiences, providing space for student's own ideas (self-expression and autonomy of children) as well as group work and collaboration. Implicitly we are guided by concerns for the environment, equity concerns, gender sensitivity and aspects of multiculturalism and inclusion. We will focus on some sample worksheets and students' responses to these. Reflection on students' responses gives some indications of future research possibilities and further development of materials. We wish to share our work with a larger group and get inputs for taking the work ahead.

Keywords: Worksheets, Collaboration, Learning, Assessment

Summer Camp activities for developing language and creativity in students

Arundhati Dolas
Discussant: Prof. Savita Ladage

Arundhati is working in D & T Lab and a member of SSRD group since 10 months. Arundhati has completed her post-graduation in Resource Management and Ergonomics. Her field of interest is into model designing, creativity.

The School Science Research Development (SSRD) team of HBCSE is working in collaboration with school teachers of a nearby local school in Mankhurd, Mumbai to enhance environmental studies teaching learning. This longitudinal Participatory Action Research (PAR) project is ongoing with this school for more than three years. Summer camps have been conducted with the schools' grade 3, 4 and 5 in the months of May 2015, 2016, and 2017, respectively. Around 15 students have voluntarily attended these summer camps. In these camps, SSRD team members introduced topics in environmental studies to the students. They also conducted other activities aimed at fostering creativity, drawing skills, language and model-making. This presentation focuses on activities aimed at language development and creativity among the students.

Language plays an important role in a child's education and it is an integral part of the interaction with students. Language enhances both social communication and cognitive development. Spoken as well as written language play a key role in teaching learning processes. In the summer camps, different activities like *akshar chitra* (letter art), reading story books, completing a story, word games, poetry composition on the basis of randomly given pictures, story writing using given words, etc. were conducted over the three one-month camps. The presentation highlights the creative use of language by students in these activities.

Key words: School Science Research Development, Summer camp, Language learning, Creativity.

Roles of Instant Messaging Environment in Knowledge Construction in CUBE Program

Jaikishan Advani, Rafikh Shaikh
Discussant: Prof. G Nagarjuna

Jaikishan works at the CUBE lab and Rafikh is a research scholar at HBCSE

We present here a program called Collaborative Undergraduate Biology Education (CUBE) which has vertical & horizontal integration of students (from schools and colleges), teachers, researchers and citizens who come together and perform advanced scientific research in the field of biology. The framework of the CUBE program is based on its ongoing-continuous collaborative engagement in hubs in colleges across the country, through online instant messaging tools and effective use of new media. Its framework serves as a "live academy" and provides an opportunity to study how such diverse community develop shared meaning and construct knowledge. In the present study, we analyse a set of conversations between students, teachers, and researchers in instant messaging environment. We look at how CUBE members interact with each other through instant messaging postings and how over the period group understanding emerges. Group interactions (specifically arguments) act as a scaffold and plays an important role in the process through which the community members develop shared meaning and construct knowledge.

Can we design interesting chemistry experiments using qualitative tests?

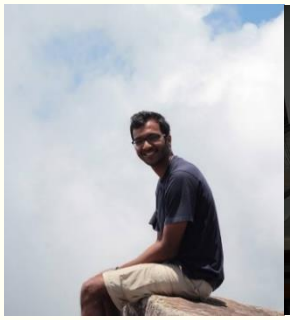
Swapna Narvekar, Indrani Das Sen
Discussant: Dr. Ankush Gupta

Swapna and Indrani are both researchers at the Chemistry education group at HBCSE

The scenario given to you involves -6 to 9 un-labelled vials and the likely list of what these solutions could be. The task is to identify the solution in each vial only through mutual reactions between these unknowns.

The current demonstration is a chemical puzzle where you identify a set of solutions using qualitative tests (colour, solubility, smell and reactions with visual changes etc.). Designing such a task is often challenging and enjoyable for students as well as for the designer of the task. We set such experiments for students studying chemistry at higher secondary level and undergraduate level. Undergraduate students while performing such experiment are expected to plan minimum number of tests to identify all the solutions using their knowledge of chemistry. This task, in addition to testing the chemistry concepts, involves the process of decision making, strategy making, hypothesis building and testing of hypothesis- which make the task challenging and interesting for the students.

A framework for students' understanding of invariance in proportion problems across grades



Chaitanya Ursekar, Jayasree Subramanian
Discussant: Dr. Aaloka Kanhere

Chaitanya and Jayasree are both 2nd year PhD students at HBCSE

Understanding proportionality involves being able to identify the ratio between two quantities and recognising situations where this ratio remains invariant. In literature, the invariant in a proportional reasoning situation is often referred to as 'an intensive quantity'. It has been reported that both children and adults face difficulties in understanding such quantities (Nunes & Bryant, 2015). Studies have suggested that students' understanding of intensive quantities may be linked to their understanding of the invariance of ratios (Harel, Behr, Lesh, & Post, 1994).

We wanted to investigate middle-school students' understanding of invariant ratios, as well as how this understanding changed with grade level. This was done using a paper-and-pencil questionnaire followed by interviews. Our questionnaire used comparison problems in three different contexts to elicit students' use of invariant ratios and intensive quantities in their explanations. The questionnaire was administered to public school students in India. 14 students of Grade 6, 17 students of Grade 8, and 18 students of Grade 10 participated in the study.

When we analysed the questionnaire responses using a bottom-up approach, we found that students could be grouped into three categories. Briefly, these are (a) pattern seekers, whose sense of invariance resulted in constant sum, difference, product, or ratio strategies for problem-solving, but who lacked awareness of the intensive quantity; (b) the formal thinkers, who seemed to have identified the invariant in a formal way without being able to associate a meaning with it; and (c) the sense-makers, who were able to identify the appropriate invariant in the context and make sense of it in the real world (Nunes & Bryant, 2015).

We then conducted interviews with three students, which indicated that students' understanding appeared to be dependent on problem contexts and the kind of calculations required. We plan to further validate and refine our framework by investigating the understanding of invariant ratios among high school students and teachers.

References

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Some educational challenges to elementary agricultural education put forth by participatory approaches

Rosemary Varkey
Discussant: Shweta Naik

Rosemary is researching on how agricultural education, science and society are interconnected. She has degrees in zoology and social work, and work experience in community development.

Education for sustainable future, socio-scientific issues, and development of science are some of her research interests.

Importance of the participation of farmers and other stakeholders in agricultural research has been recognized for more than three decades. However, out-of-hand rejection of farmers' alternative knowledge's and innovative practices that has achieved in some places spectacular results and has spread widely, are also reported often. Many development workers conclude that the causes for this comes down to educational systems that set the parameters for professional and organisational behaviour. Thus, development workers who advocate for participatory approaches have identified 'supporting curriculum design and development processes for agricultural education from schools to skill-based training to professional and tertiary education' as one necessary area of intervention.

In this backdrop, this presentation reports a preliminary investigation on the approaches of some Indian school science textbooks while dealing with the topic agriculture. Though 'transfer of technology' approaches still dominate this field, a few examples of participatory approaches are also seen in some recent textbooks.

I will also give examples of how the farmers with whom I conducted interviews strengthens the argument for participatory approaches. The presentation ends with a brief discussion on the educational challenges posed by the proponents of participatory approaches.

Keywords: agricultural education, participatory approaches, STSE education

Student questioning in student-student discourse: Understanding the process and its role in doing science

Gurinder Singh
Discussant: Ruchi Kumar

My research involves understanding the dynamics of student questioning and its role in doing science in outside classroom contexts

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Student questioning has been recognised as a key aspect in doing and learning science. However classroom studies report a lack of student questioning and student talk with domination of teacher questioning and teacher talk. This is particularly true for Indian classrooms. Though there are fewer recent classroom studies on student questioning, the situation does not seem be very different than what it was 30-40 years back. A large part of student questioning research has focused on the forms and functions of student questioning and encouraging and training students at asking better questions. Many such studies look at questions in isolation from the context in which they arise. In our review of research in student questioning we found a lack of studies looking at the process of student questioning and its role in doing science. We also found a lack of studies looking at the role of student questioning in their argumentation. By presenting our theoretical critique of the literature on student questioning research, we propose here that unless we understand the process and dynamics of student questioning and its role in doing science, we cannot create classrooms contexts where students ask and answer their own questions.

Keywords - Student questioning, student talk, process of questioning, process of science

Doing Science: Making a start for primary and middle school students

Sujatha Varadarajan
Discussant: Dr. Rohini Karandikar

Sujatha is a Research Scholar at HBCSE

Science textbooks give students content knowledge, which amounts to exposing students to Theories and Laws and not the process of arriving at it. Further, school science experiments are largely meant only for secondary and higher secondary students. We often neglect engaging primary and middle school students with the process of scientific thinking (comprising logic and rationality) and also neglect utilizing laboratory space to introduce process skills and attitude in an active way. Some of the reasons for this neglect are quoted to be inadequate staff exposure, infrastructure, resources, safety etc.

To address this issue, an empirical study was conducted with a small group (n=18) of primary and middle school students from different schools who were engaged in a post-school activity during weekends at Pune. The focus of the study was exploring activities (requiring limited resources) that can help us to introduce scientific thinking and process skills to primary and middle school students. The study also aimed to understand the level of student responses by giving affordance for articulation and collaborative learning which generally they are deprived of in a typical school environment.

The activities were designed to help students see the difference between science and scientific thinking by involving them in meaningful discussion, investigation, observations, data collection and reviewing all of it critically in a collective way. While we explored the scope to touch upon the affective domain by way of giving students' the freedom to express and conduct the experiment with chemicals etc., students started to get a sense of the scientific process and how different process stages could apply to different topics. Middle school students engaged in model-based reasoning while primary students learned to collect data. However, attempts to introduce the idea of factors that affect the results of the experiment were less fruitful with this group of students.

Title: Characterizing the argumentation arising in two different classrooms

Jeenath Rahman
Discussant: Rossi D'Souza

I'm a PhD student from HBCSE working in the field of mathematics education and cognition. My PhD work is in looking at student's construction of the concept of area measurement. I'm also working as a research associate in the CLIx project in TISS. In this meet, I would like to share an analysis of my different experiences in teaching and learning from a socio-cultural perspective.

Argumentation is seen to play an important role in education. In the present report, I will contrast and characterize the nature of argumentation arising in two different classroom contexts. The content taught in the two classrooms is broadly the same, but the two classrooms were different in several aspects. The first section of this report is about the socio-cultural profile of the two classrooms that includes student's profile, school's profile, textbooks, teachers profile in the respective classrooms.
By characterizing the argumentation in these two contexts, I would like to explore and address the following questions?
1. Does the socio-cultural profile impact the nature of argumentation happening in the classroom? How?
2. What is the relation between the nature of argumentation and the construction of a particular concept (or knowledge)?

Through this report, I would like to touch upon the nature of argumentation in a classroom context. I would also like to report the conflicts arising in the process of teaching a particular content (area-measurement).