e-Learning Korea 2017

Multimodal Learning Analytics

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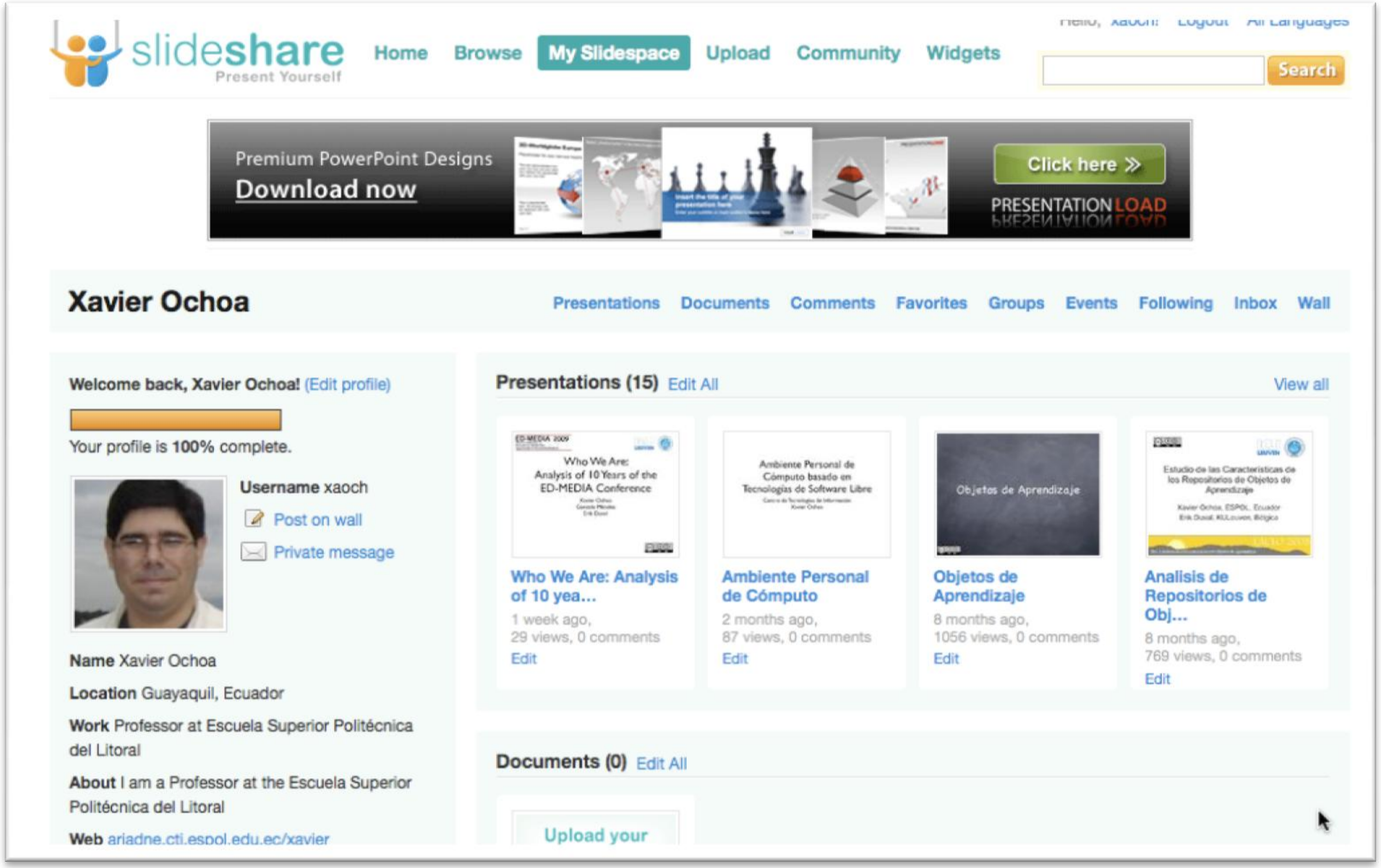


http://www.slideshare.net/xaoch

(Multimodal)
Learning Analytics

Learning analytics is the *measurement*, *collection*, *analysis* and *reporting* of data about **learners** and **their contexts**, for purposes of *understanding* and *optimising* **learning** and the environments in which it occurs.

Examining engagement: analysing learner subpopulations in massive open online courses (MOOCs)

Using transaction-level data to diagnose knowledge gaps and misconceptions

Likelihood analysis of student enrollment outcomes using learning environment variables: a case study approach

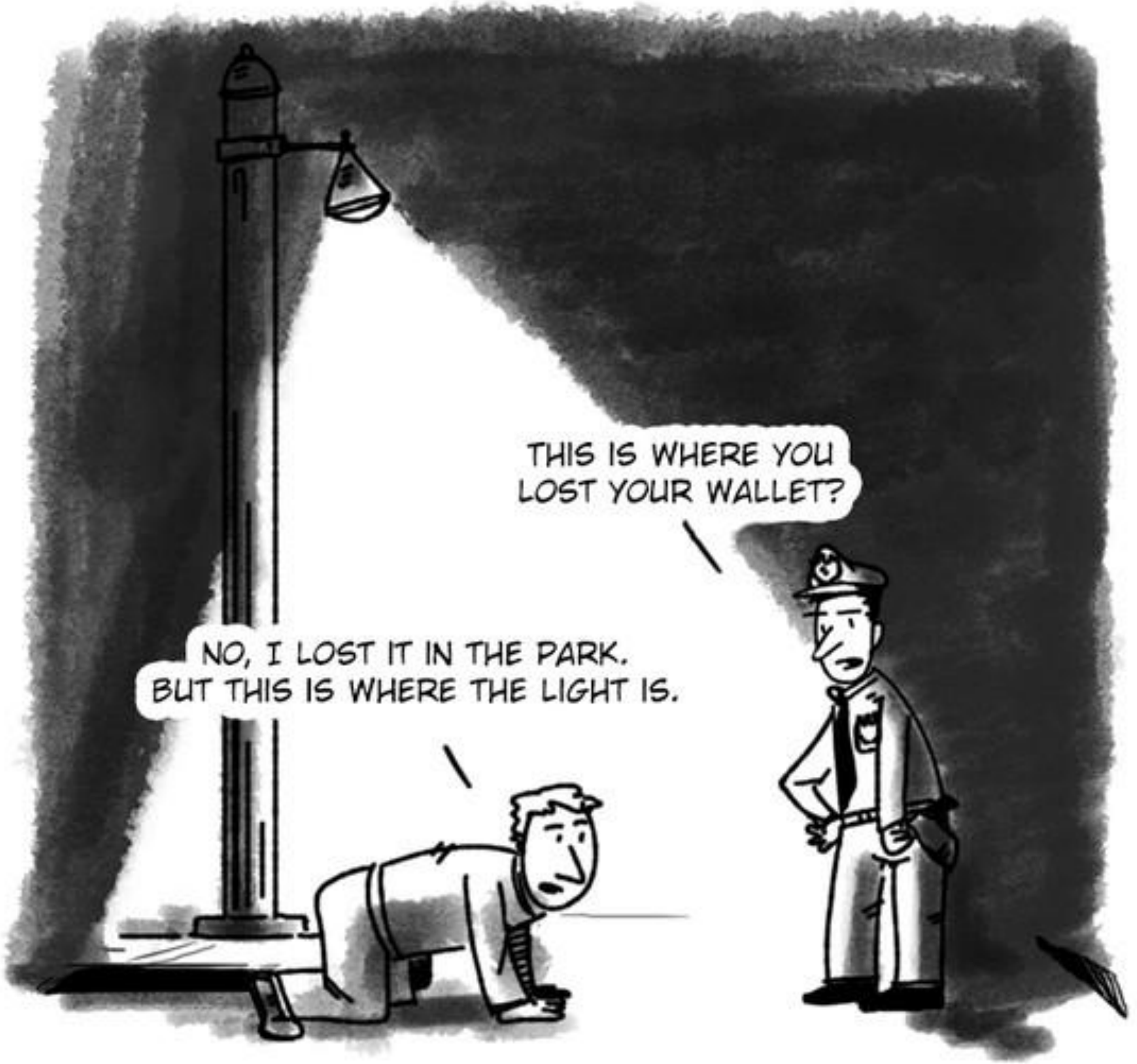
Tracking student progress in a game-like learning environment with a Monte Carlo Bayesian knowledge tracing model

Strong focus on online data

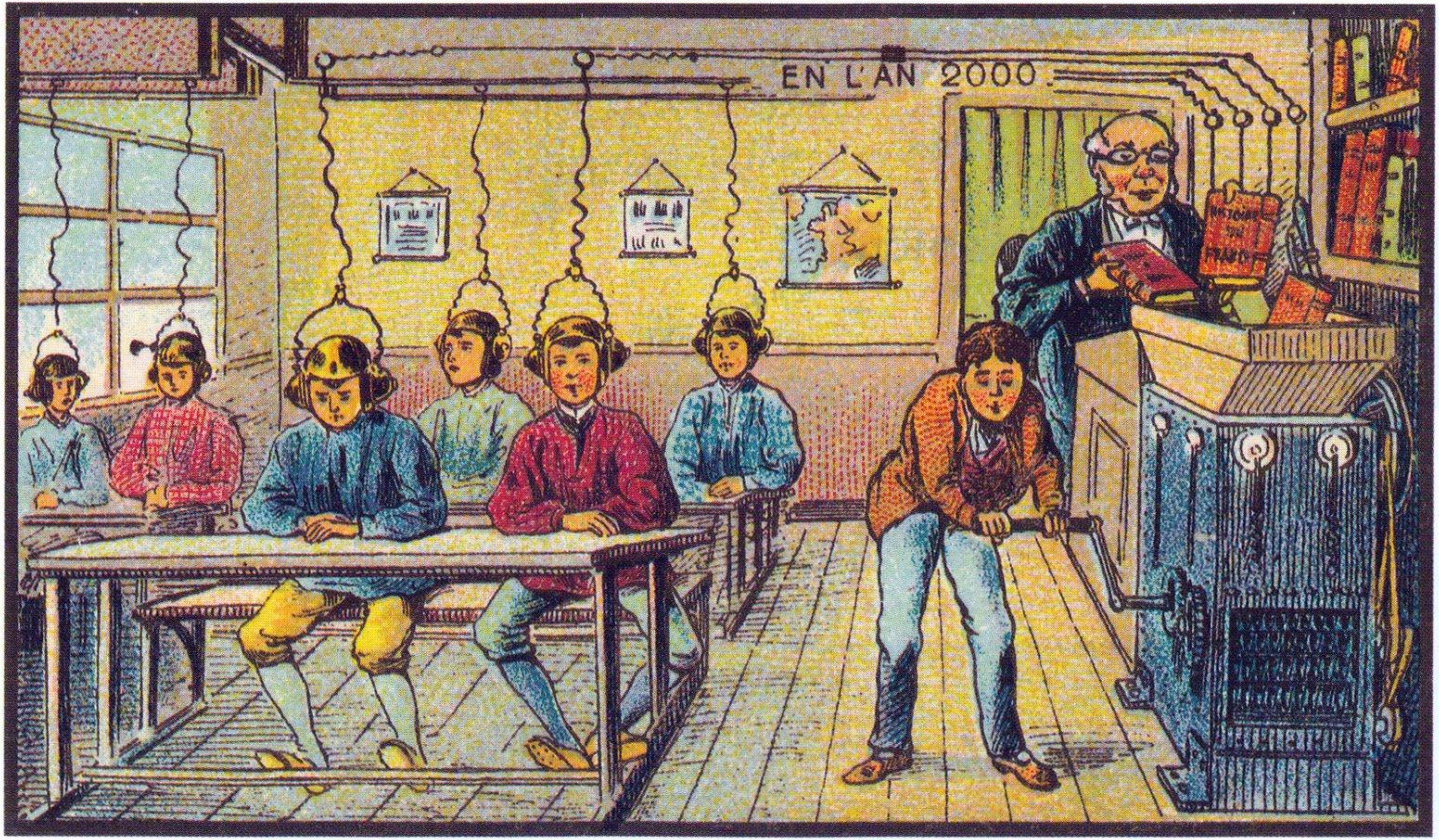
Based on the papers it should be called

Online-Learning Analytics

Streetlight effect



Where learning is happening?



At School

Why
Multimodal Learning Analytics?

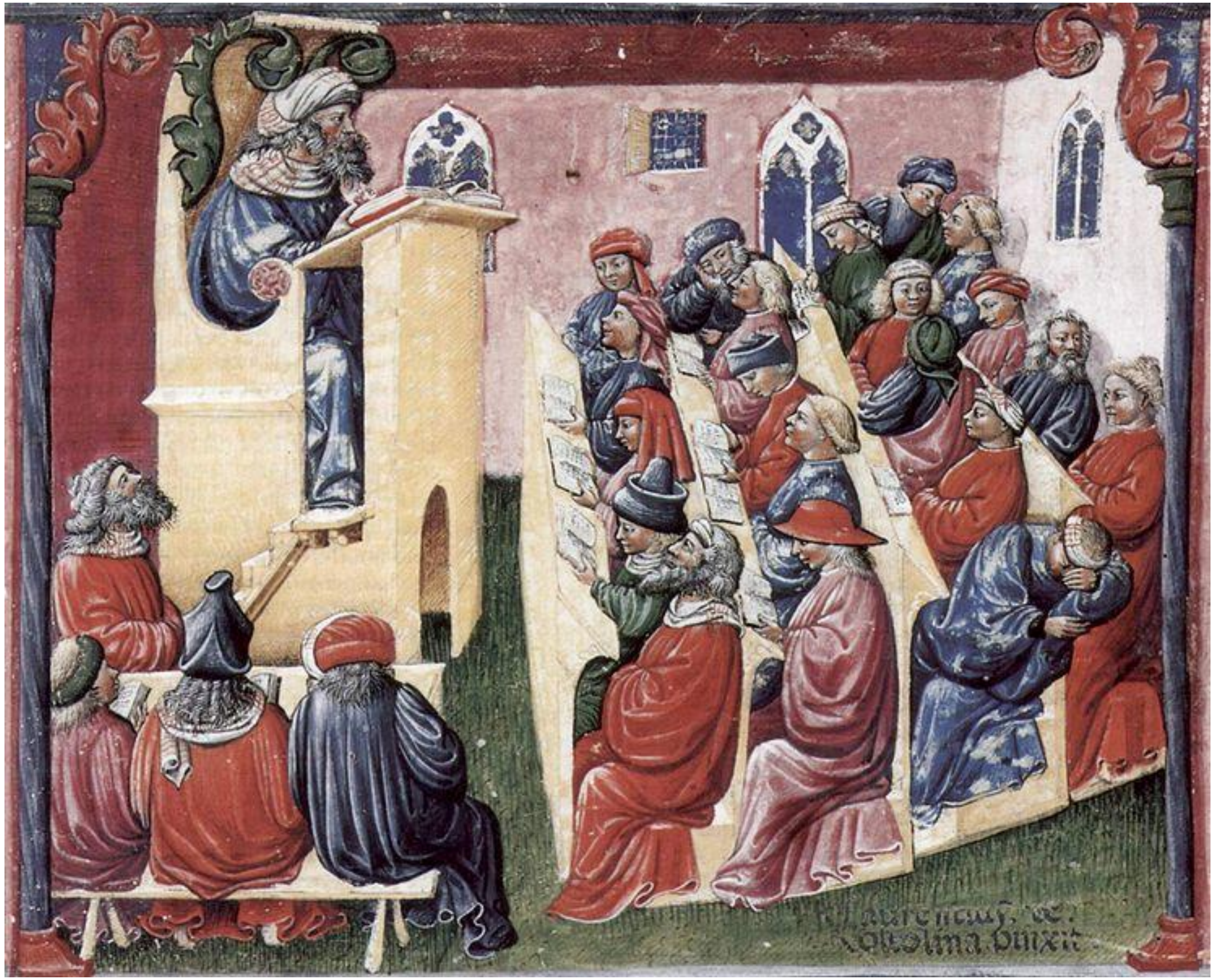
We should be looking where it is useful to look,
not where it is easy

There is learning outside the LMS

But it is very messy!

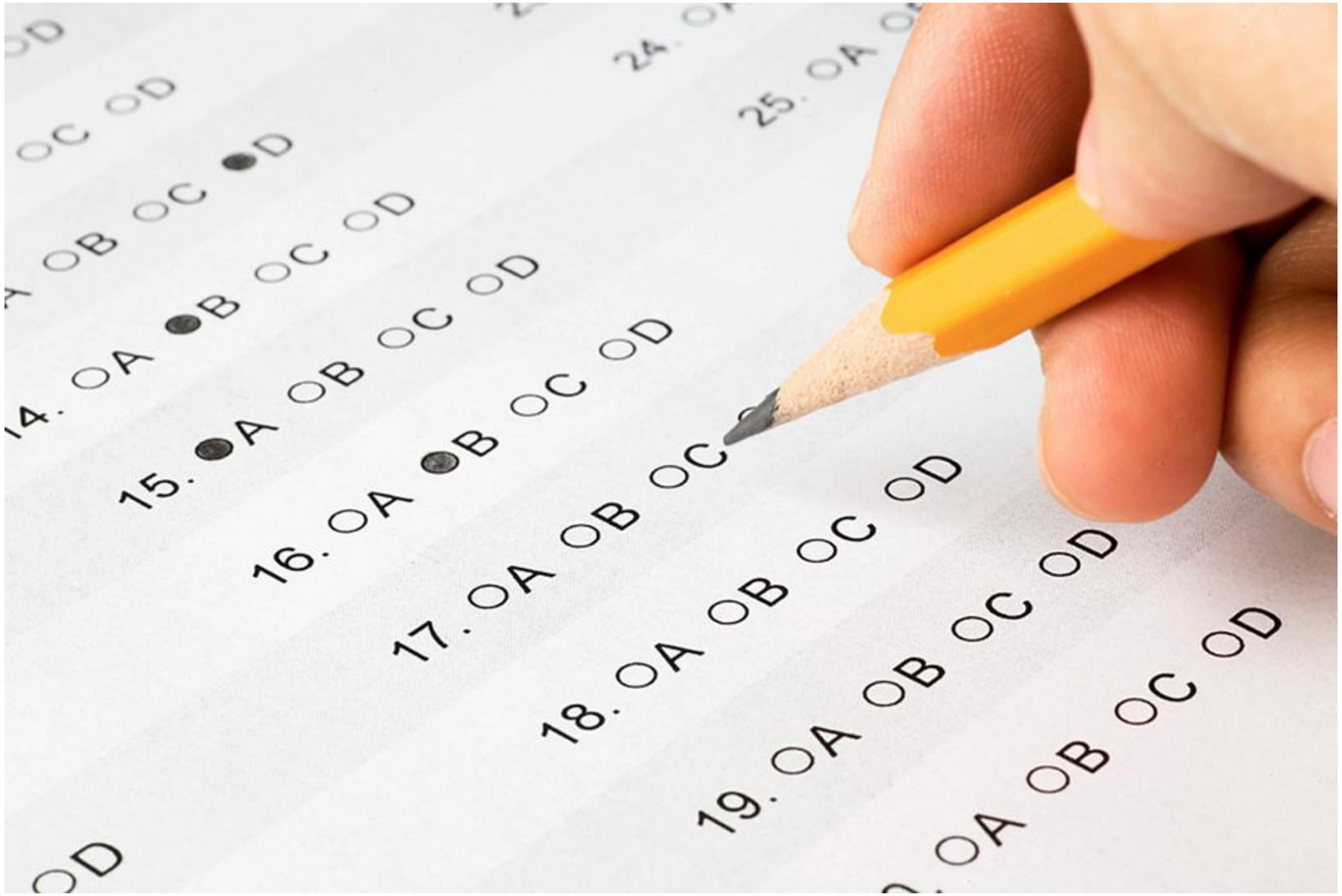
Who is learning?

Who is learning?



Who is learning?

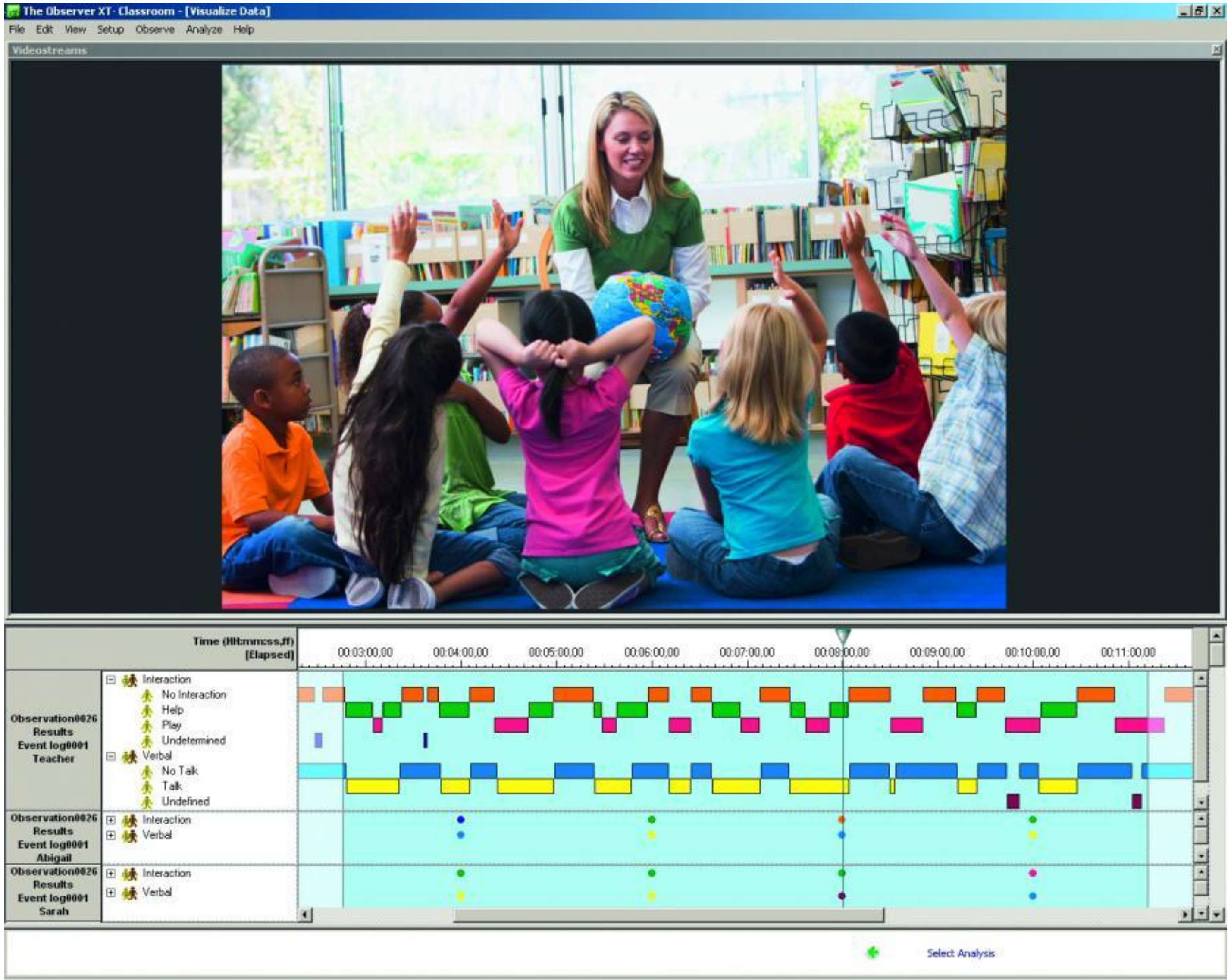
Who is learning? – Traditional way

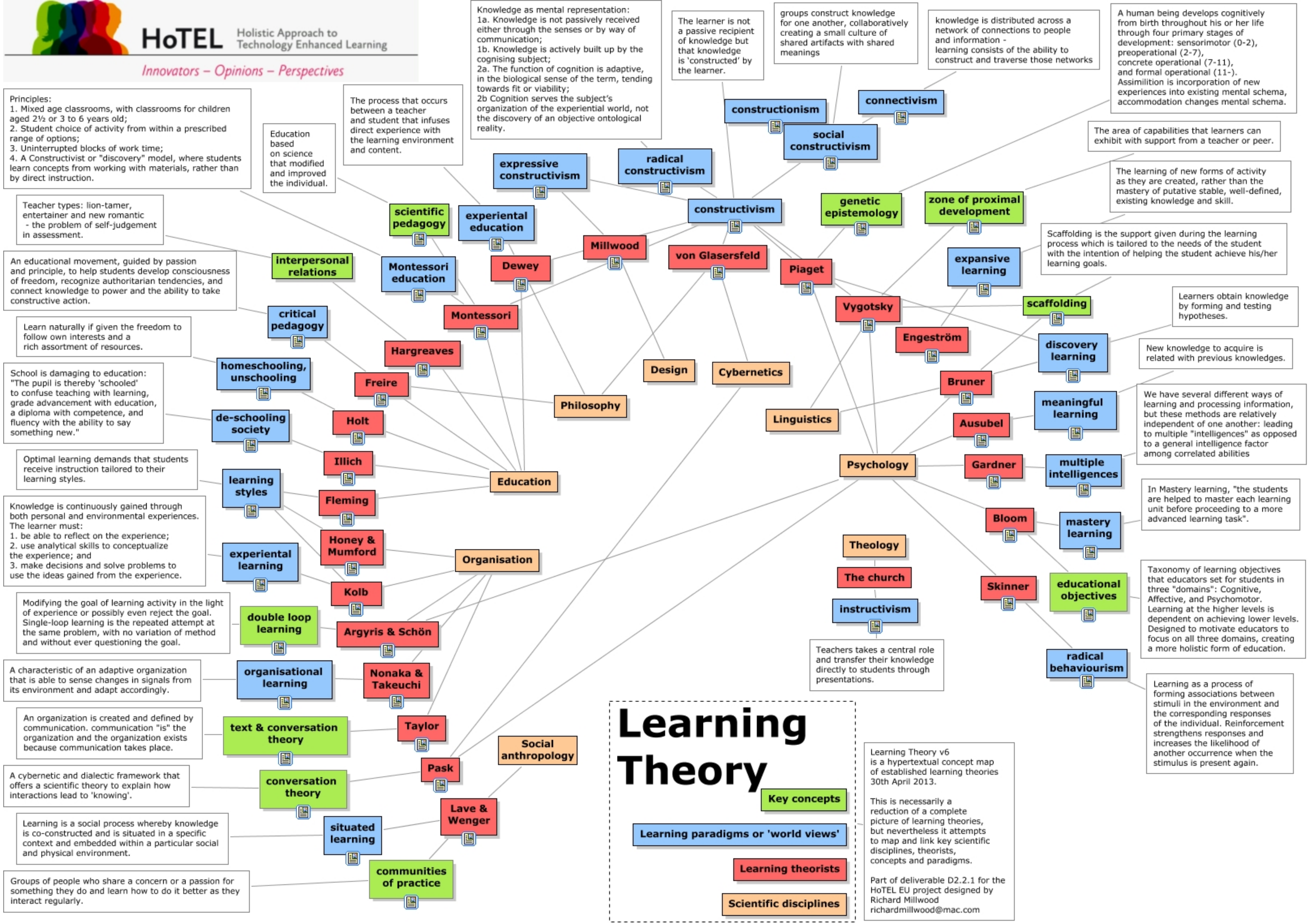


But there are better ways to assess learning

At least theoretically

Who is learning? – Educational Research




HoTEL Holistic Approach to Technology Enhanced Learning
Innovators – Opinions – Perspectives
Learning Theory
Key concepts
Learning paradigms or 'world views'
Learning theorists
Scientific disciplines
Learning Theory v6 is a hypertextual concept map of established learning theories 30th April 2013.
This is necessarily a reduction of a complete picture of learning theories, but nevertheless it attempts to map and link key scientific disciplines, theorists, concepts and paradigms.
Part of deliverable D2.2.1 for the HoTEL EU project designed by Richard Millwood richardmillwood@mac.com
Principles: 1. Mixed age classrooms, with classrooms for children aged 2½ or 3 to 6 years old; 2. Student choice of activity from within a prescribed range of options; 3. Uninterrupted blocks of work time; 4. A Constructivist or "discovery" model, where students learn concepts from working with materials, rather than by direct instruction.
Education based on science that modified and improved the individual.
The process that occurs between a teacher and student that infuses direct experience with the learning environment and content.
Knowledge as mental representation: 1a. Knowledge is not passively received either through the senses or by way of communication; 1b. Knowledge is actively built up by the cognising subject; 2a. The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability; 2b Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.
The learner is not a passive recipient of knowledge but that knowledge is 'constructed' by the learner.
groups construct knowledge for one another, collaboratively creating a small culture of shared artifacts with shared meanings
knowledge is distributed across a network of connections to people and information - learning consists of the ability to construct and traverse those networks
A human being develops cognitively from birth throughout his or her life through four primary stages of development: sensorimotor (0-2), preoperational (2-7), concrete operational (7-11), and formal operational (11-). Assimilition is incorporation of new experiences into existing mental schema, accommodation changes mental schema.
The area of capabilities that learners can exhibit with support from a teacher or peer.
The learning of new forms of activity as they are created, rather than the mastery of putative stable, well-defined, existing knowledge and skill.
Scaffolding is the support given during the learning process which is tailored to the needs of the student with the intention of helping the student achieve his/her learning goals.
Learners obtain knowledge by forming and testing hypotheses.
New knowledge to acquire is related with previous knowledges.
We have several different ways of learning and processing information, but these methods are relatively independent of one another: leading to multiple "intelligences" as opposed to a general intelligence factor among correlated abilities
In Mastery learning, "the students are helped to master each learning unit before proceeding to a more advanced learning task".
Taxonomy of learning objectives that educators set for students in three "domains": Cognitive, Affective, and Psychomotor. Learning at the higher levels is dependent on achieving lower levels. Designed to motivate educators to focus on all three domains, creating a more holistic form of education.
Learning as a process of forming associations between stimuli in the environment and the corresponding responses of the individual. Reinforcement strengthens responses and increases the likelihood of another occurrence when the stimulus is present again.
Teachers takes a central role and transfer their knowledge directly to students through presentations.
Teacher types: lion-tamer, entertainer and new romantic - the problem of self-judgement in assessment.
An educational movement, guided by passion and principle, to help students develop consciousness of freedom, recognize authoritarian tendencies, and connect knowledge to power and the ability to take constructive action.
Learn naturally if given the freedom to follow own interests and a rich assortment of resources.
School is damaging to education: "The pupil is thereby 'schooled' to confuse teaching with learning, grade advancement with education, a diploma with competence, and fluency with the ability to say something new."
Optimal learning demands that students receive instruction tailored to their learning styles.
Knowledge is continuously gained through both personal and environmental experiences. The learner must: 1. be able to reflect on the experience; 2. use analytical skills to conceptualize the experience; and 3. make decisions and solve problems to use the ideas gained from the experience.
Modifying the goal of learning activity in the light of experience or possibly even reject the goal. Single-loop learning is the repeated attempt at the same problem, with no variation of method and without ever questioning the goal.
A characteristic of an adaptive organization that is able to sense changes in signals from its environment and adapt accordingly.
An organization is created and defined by communication. communication "is" the organization and the organization exists because communication takes place.
A cybernetic and dialectic framework that offers a scientific theory to explain how interactions lead to 'knowing'.
Learning is a social process whereby knowledge is co-constructed and is situated in a specific context and embedded within a particular social and physical environment.
Groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.
scientific pedagogy
experiential education
expressive constructivism
radical constructivism
constructionism
social constructivism
connectivism
constructivism
genetic epistemology
zone of proximal development
expansive learning
scaffolding
discovery learning
meaningful learning
multiple intelligences
mastery learning
educational objectives
radical behaviourism
interpersonal relations
Montessori education
critical pedagogy
homeschooling, unschooling
de-schooling society
learning styles
experiential learning
double loop learning
organisational learning
text & conversation theory
conversation theory
situated learning
communities of practice
instructivism
Millwood
Dewey
von Glasersfeld
Piaget
Vygotsky
Engeström
Montessori
Hargreaves
Freire
Holt
Illich
Fleming
Honey & Mumford
Kolb
Argyris & Schön
Nonaka & Takeuchi
Taylor
Pask
Lave & Wenger
Bruner
Ausubel
Gardner
Bloom
Skinner
The church
Design
Cybernetics
Philosophy
Linguistics
Education
Psychology
Organisation
Theology
Social anthropology

How can we approach the problem from a Learning Analytics perspective

Measure, collect, analyze and report
to understand and optimize

We need to capture learning traces from the real world

Look ma, no log files!

In the real world, humans communicate (and leave traces) in several modalities

What you say is as important as how you say it

We need to analyze the traces with variable degrees of sophistication

And we have to do it automatically as humans are not scalable

We need to provide feedback in the real world

Often in a multimodal way too

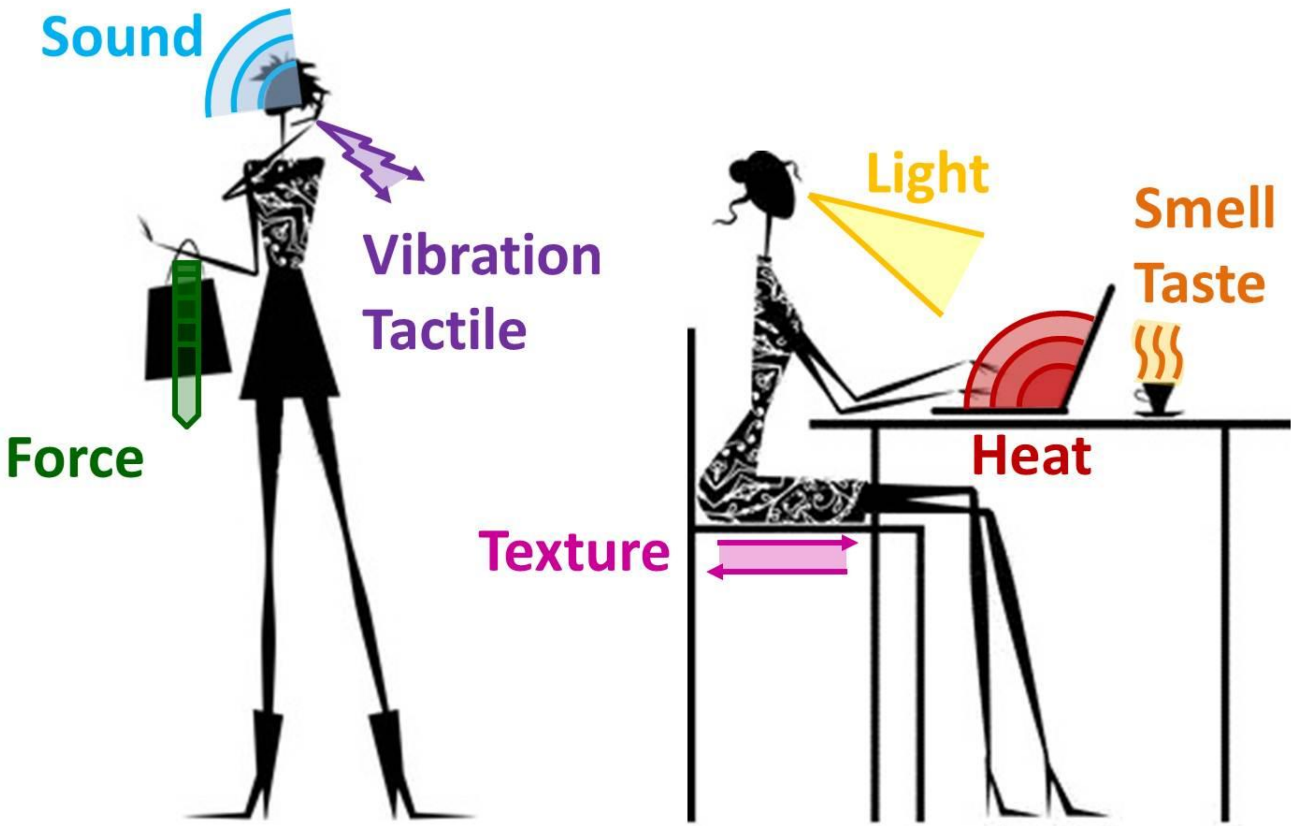
But…

Which modes are important to understand the learning process?

We do not know yet…

Possibilities

- What we see
- What we hear
- How we move
- How we write
- How we blink
- Our pulse
- Brain activity?
- Our hormones?



What are the relevant features of those signals

We do not know yet…

Our current analysis tools are good enough?

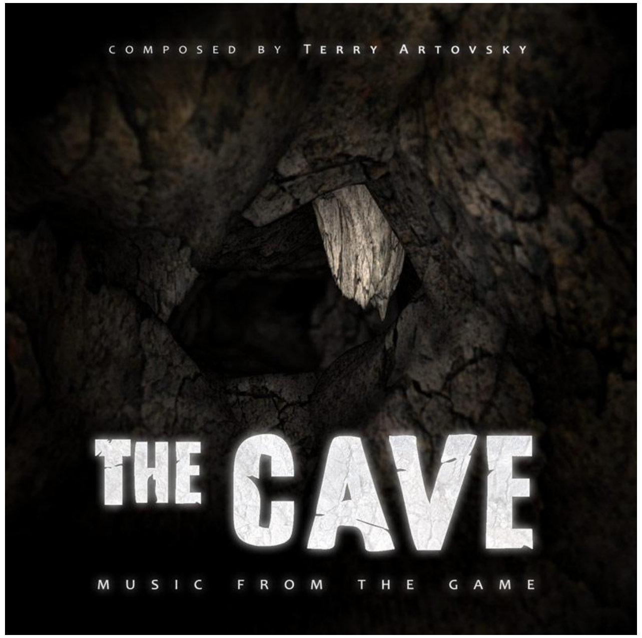
We do not know yet…

How to present the information (and uncertainty) in a way that is actually useful?

We do not know yet…

It is an open (but very dark) field

One feels like an explorer



This particular flavor of Learning Analytics is what we called Multimodal Learning Analytics

Multimodal Learning Analytics is related to:

- Behaviorism
- Cognitive Science
- Multimodal Interaction (HCI)
- Educational Research (old school one)
- Computer Vision
- Natural Language Processing
- Biosignals Processing
- And as many fields as modes you can think of...

Examples

Expertise Estimation based on Simple Multimodal Features

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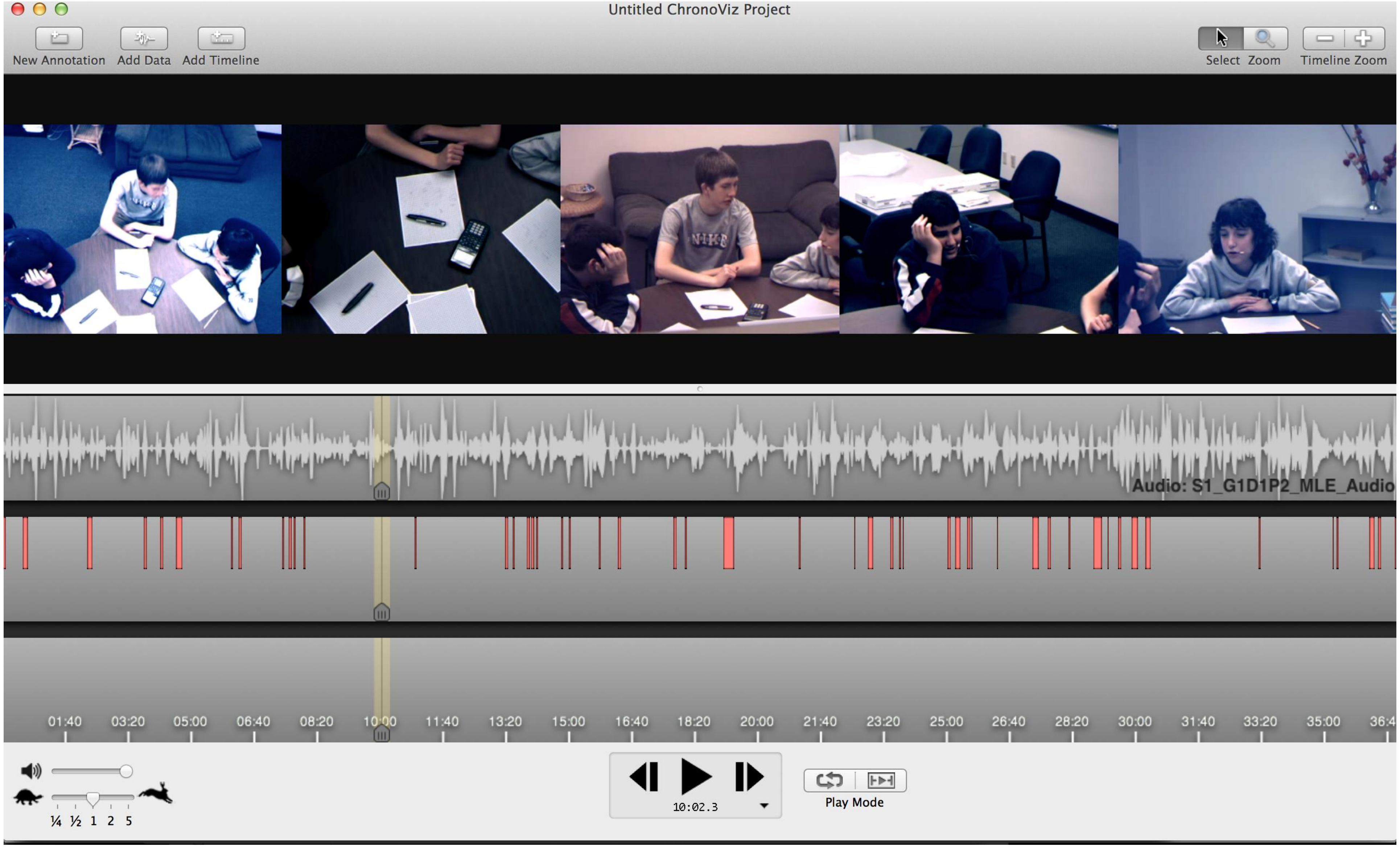
ABSTRACT

Multimodal Learning Analytics is a field that studies how to process learning data from dissimilar sources in order to automatically find useful information to give feedback to the learning process. This work processes video, audio and pen strokes information included in the Math Data Corpus, a set of multimodal resources provided to the participants of the Second International Workshop on Multimodal Learning Analytics. The result of this processing is a set of simple features that could discriminate between experts and non-experts in groups of students solving mathematical problems. The main finding is that several of those simple features, namely the percentage of time that the students

majority of relevant actions are by necessity kept on record, in learning, much of what happens during the process is not recorded and cannot be used to evaluate it.

The most readily available sources of learning data are the interactions of students and instructors in e-learning platforms. As most of these tools keep detailed logs of access and content consumption and production, it helps researchers to collect and process large amount of data that could provide insight in the usage and interactions within these tools. Yet, most of the traditional learning processes occurs in face-to-face settings with very little record keeping, apart from the memory of the participants and short and unstructured notes made by the instructors and students. To avoid the proverbial mistake of only searching where it is

Math Data Corpus



How to (easily) obtain multimodal features?

What is already there?

Three Approaches

- Literature-based features

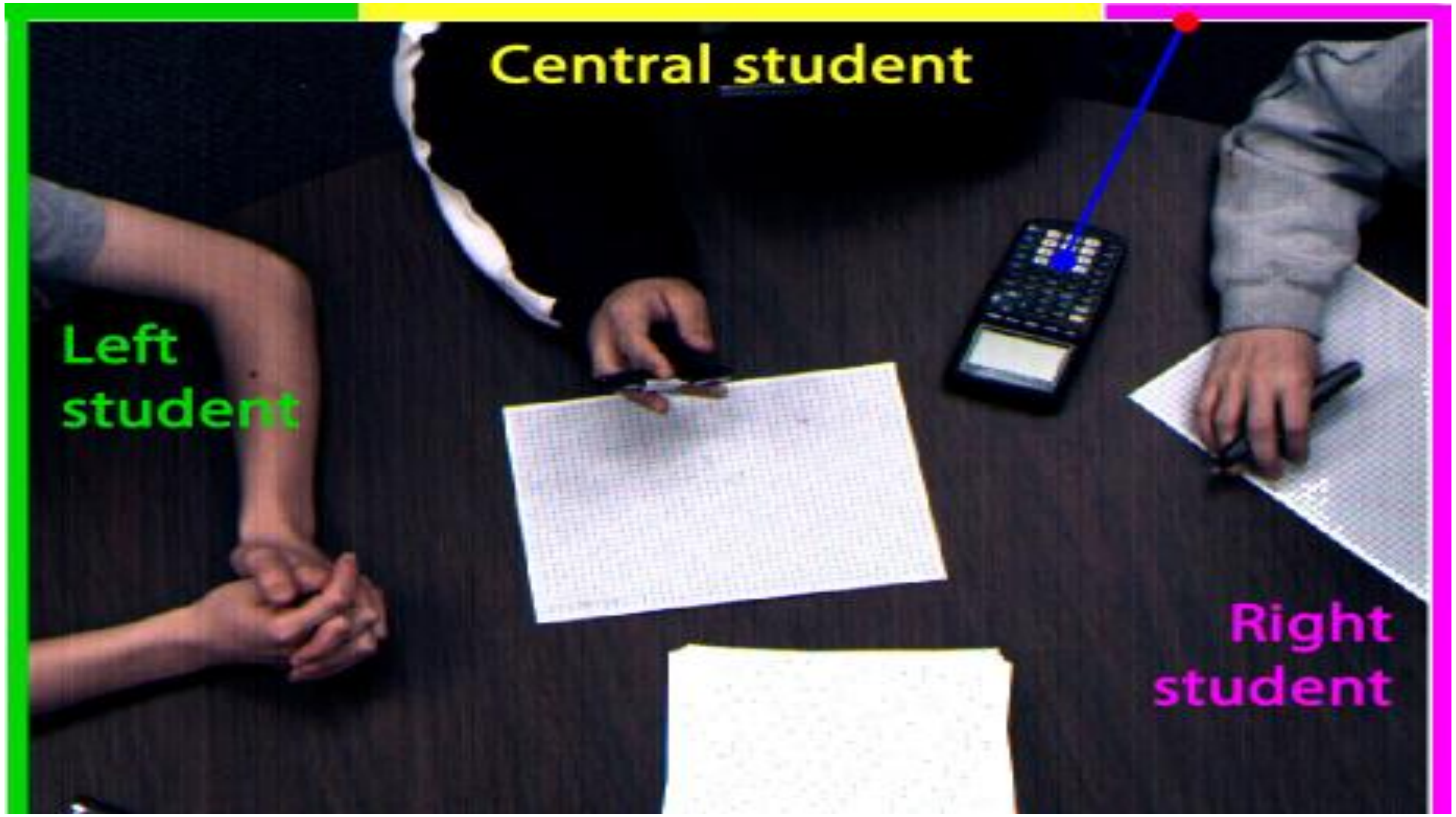
- Common-sense-based features

- “Why not?”-based features

All approaches proved useful

Proof that we are in an early stage

Video: Calculator Use (NTCU)



Video: Calculator Use (NTCU)

- Idea:
  - Calculator user is the one solving the problem
- Procedure:
  - Obtain a picture of the calculator
  - Track the position and angle of the image in the video using SURF + FLANN + Rigid Object Transformation (OpenCV)
  - Determine to which student the calculator is pointing in each frame

Video: Total Movement (TM)

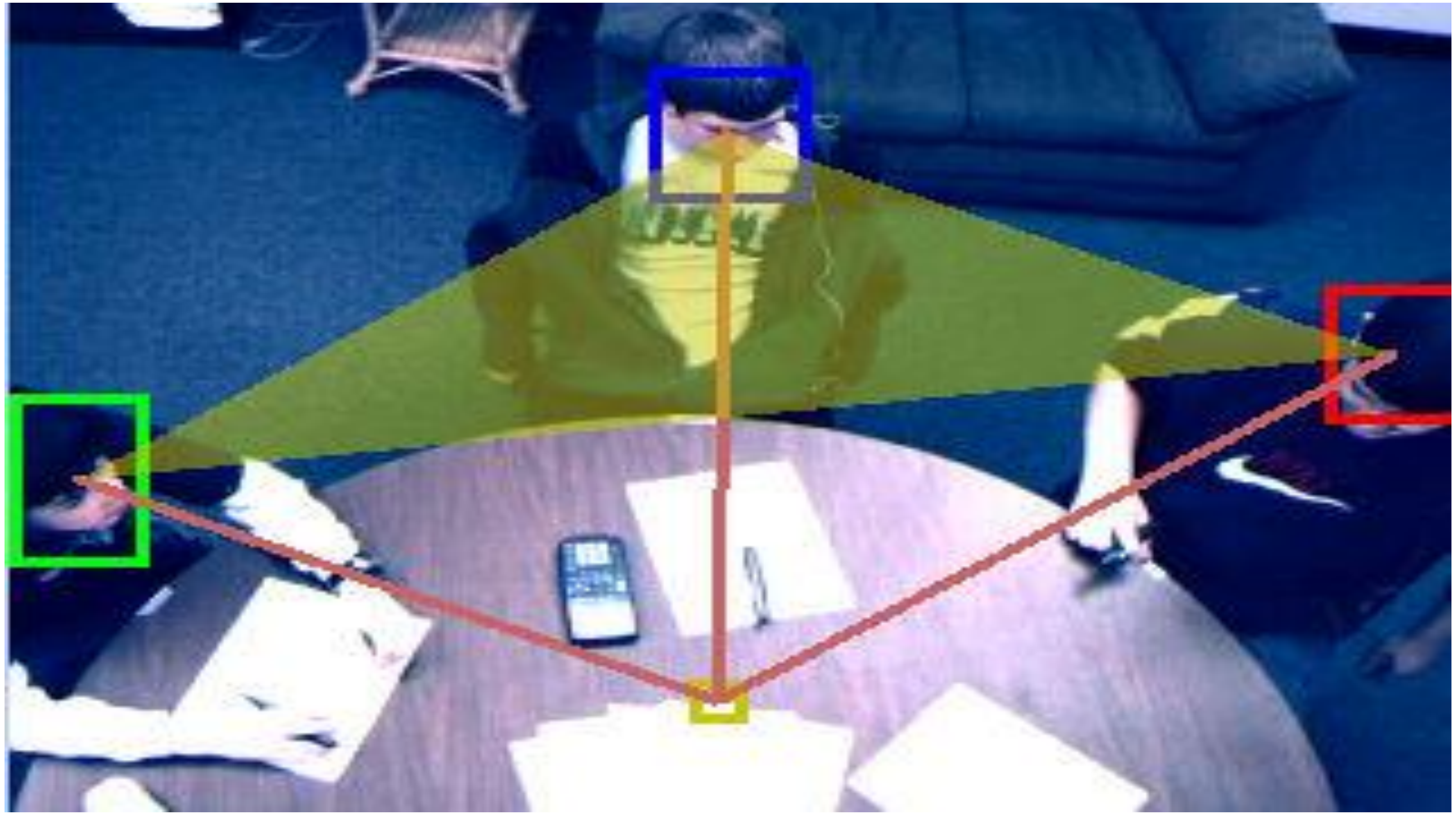
(a) Original frame

(b) Difference frame

Video: Total Movement (TM)

- Idea:
  - Most active student is the leader/expert?
- Procedure:
  - Subtract current frame from previous frame
  - Codebook algorithm to eliminate noise-movement
  - Add the number of remaining pixels

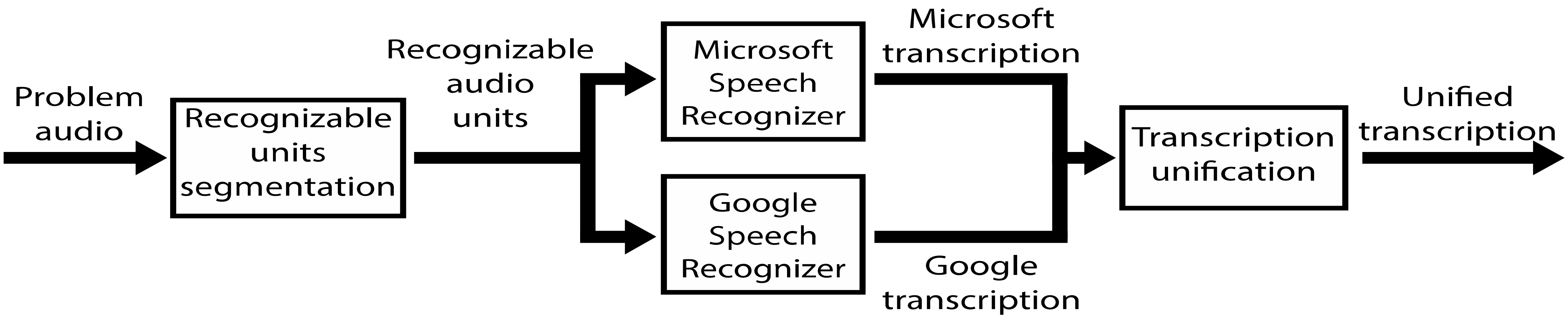
Video: Distance from center table (DHT)



Video: Distance from center table (DHT)

- Idea:
  - If the head is near the table (over paper) the student is working on the problem
- Procedure:
  - Identify image of heads
  - Use TLD algorithm to track heads
  - Determine the distance from head to center of table

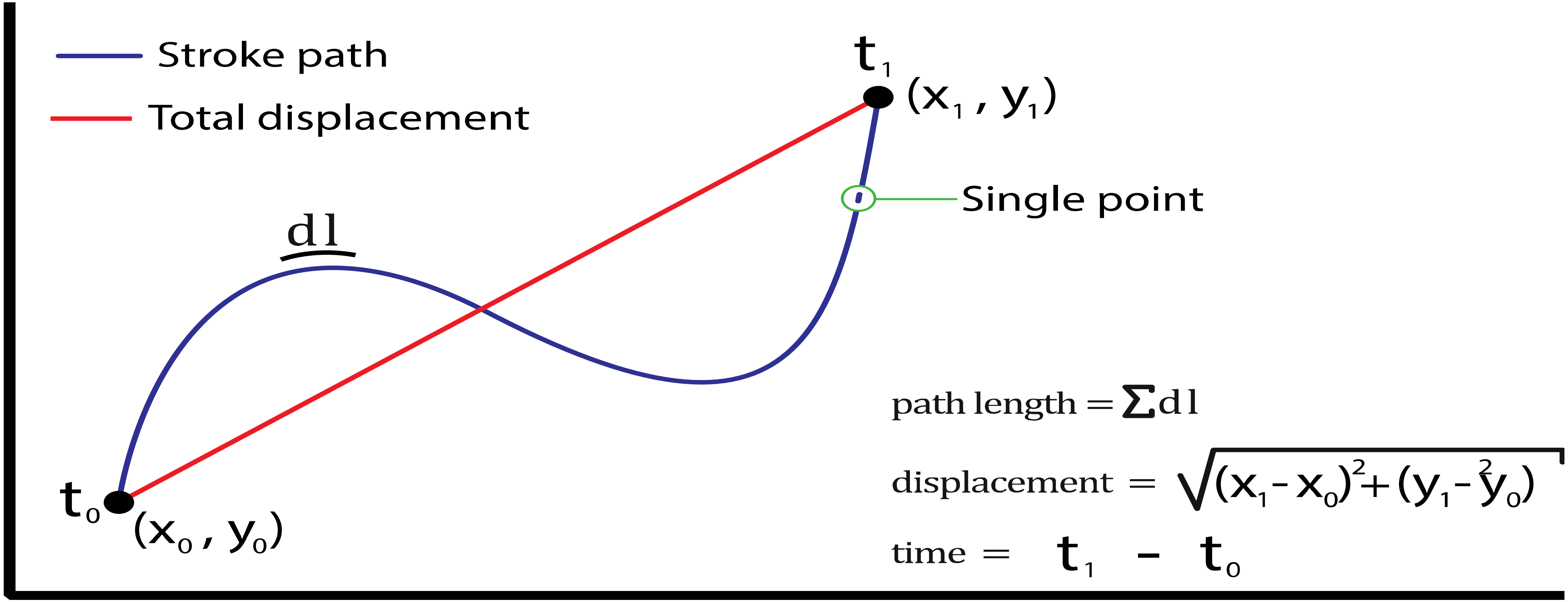
Audio: Processing



Audio: Features

- Number of Interventions (NOI)
- Total Speech Duration (TSD)
- Times Numbers were Mentioned (TNM)
- Times Math Terms were Mentioned (TMTM)
- Times Commands were Pronounced (TCP)

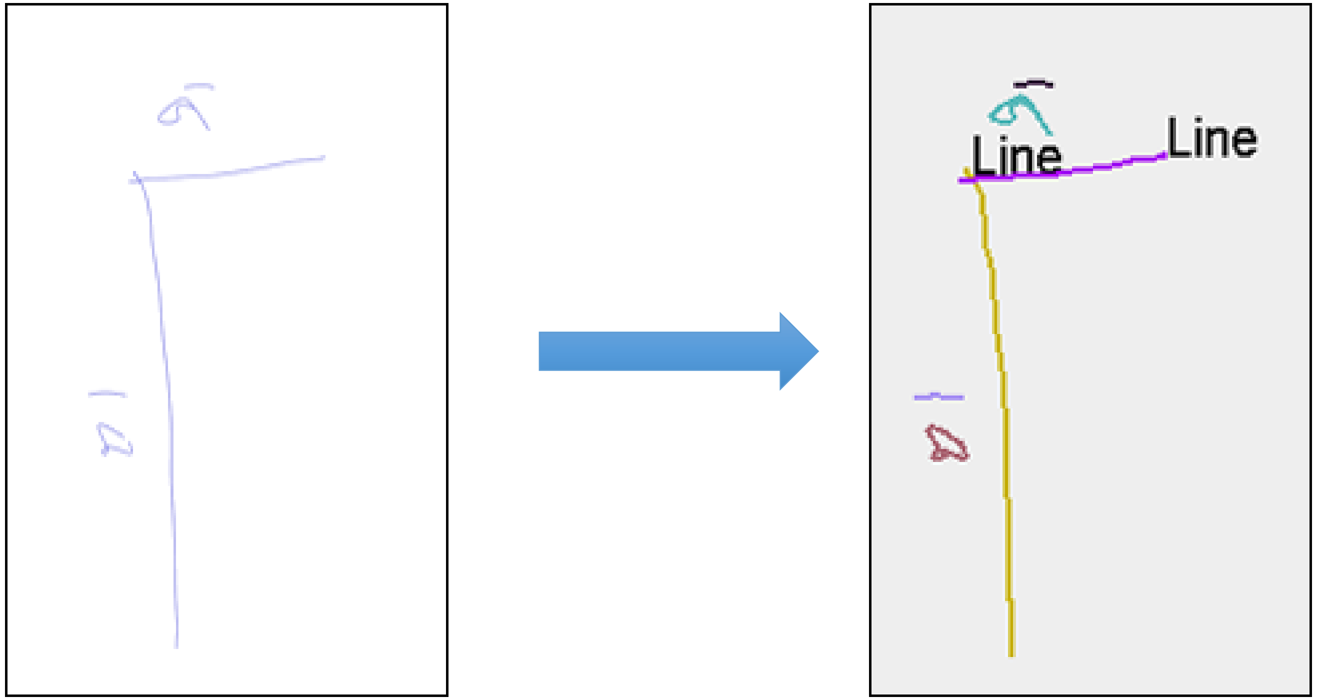
Digital Pen: Basic Features



Digital Pen: Basic Features

- Total Number of Strokes (TNS)
- Average Number of Points (ANP)
- Average Stroke Path Length (ASPL)
- Average Stroke Displacement (ASD)
- Average Stroke Pressure (ASP)

Digital Pen: Shape Recognition



Stronium – Sketch Recognition Libraries

Digital Pen: Shape Recognition

- Number of Lines (NOL)
- Number of Rectangles (NOR)
- Number of Circles (NOC)
- Number of Ellipses (NOE)
- Number of Arrows (NOA)
- Number of Figures (NOF)

Analysis at Problem level
Solving Problem Correctly

- Logistic Regression to model Student Solving Problem Correctly
- Resulting model was significantly reliable
- 60,9% of the problem solving student was identified
- 71,8% of incorrectly solved problems were identified

Analysis at problem level

Predictor Variable	B	Wald	df	p value	exp(B)
Number of Interventions (NOI)	0.068	24.019	1	0.001	0.934
Times numbers were mentioned (TNM)	0.175	23.816	1	0.001	1.192
Times commands were pronounced (TCP)	0.329	4.956	1	0.026	1.390
Proportion of Calculator Usage (PCU)	1.287	25.622	1	0.001	3.622
Fastest Student in the Group (FW)	0.924	18.889	1	0.001	2.519
Constant	1.654	53.462	1	0.001	0.191

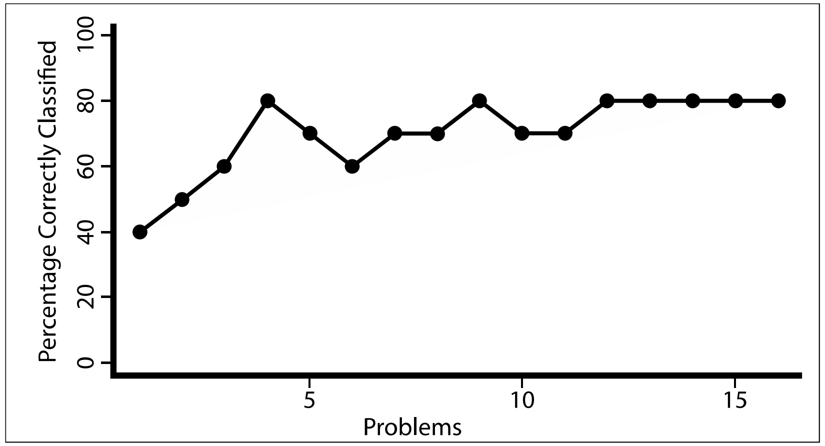
Analysis at Group Level
Expertise Estimation

- Features were feed to a Classification Tree algorithm
- Several variables had a high discrimination power between expert and non-experts
- Best discrimination result in 80% expert prediction and 90% non-expert prediction

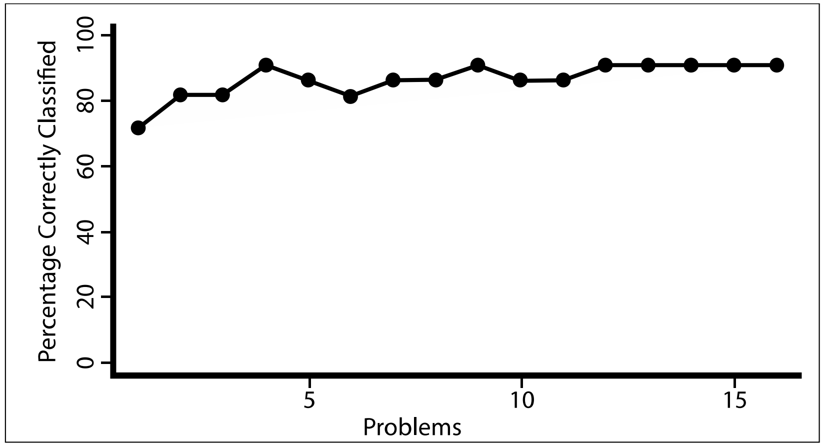
Analysis at Group Level
Expertise Estimation

Variable	Value for Experts	Discrimination Power
FW	> 0.5	6.53
LP	> 34.74	6.53
PCU	> 38.05	4.44
MN	> 0.13	4.03
PNM	> 6.25	3.19

Expert Estimation over Problems



(a) Evolution of Expert Classification



(b) Evolution of Non-Expert Classification

Plateau reached after just 4 problems

Main conclusion: Simple features could identify expertise

Faster Writer (Digital Pen)

Percentage of Calculator Use (Video)

Times Numbers were Mentioned (Audio)

Presentation Skills Estimation Based on Video and Kinect Data Analysis

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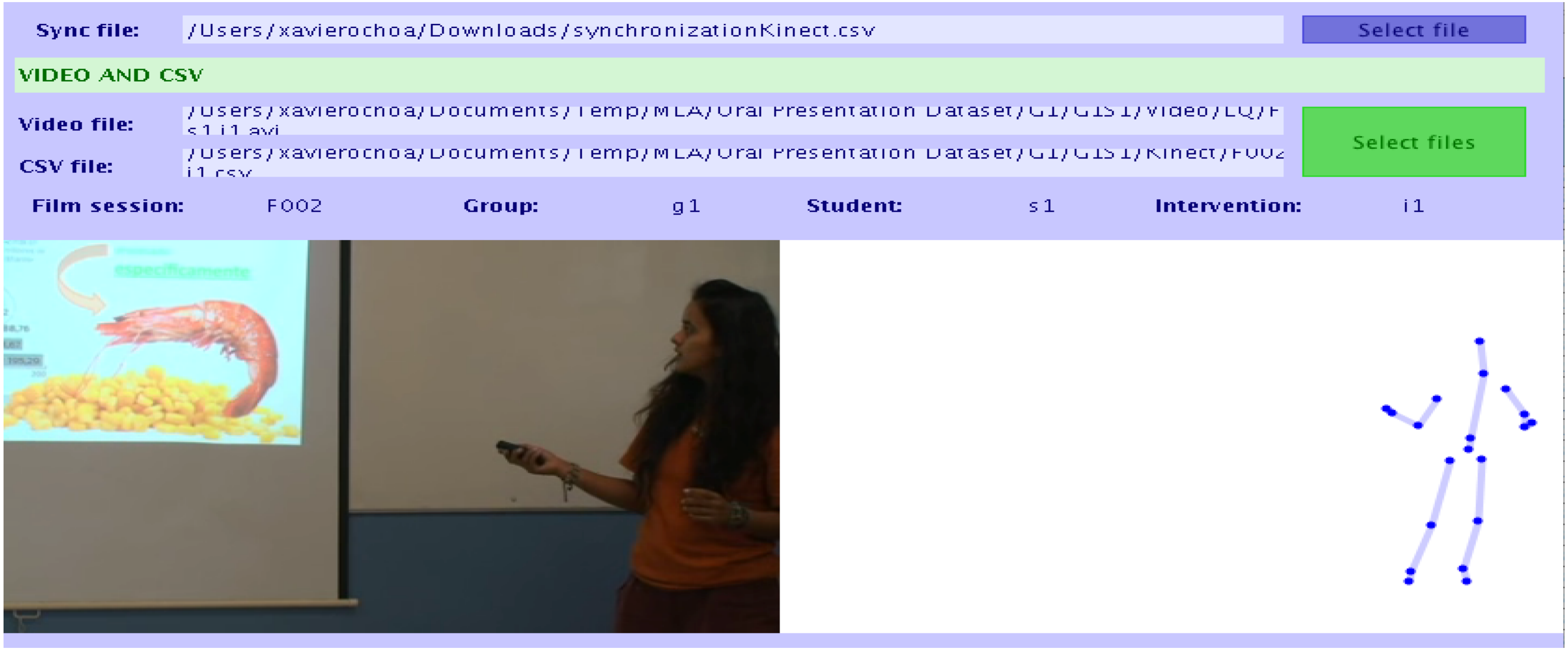
ABSTRACT

This paper identifies, by means of video and Kinect data, a set of predictors that estimate the presentation skills of 449 individual students. Two evaluation criteria were predicted: eye contact and posture and body language. Machine-learning evaluations resulted in models that predicted the levels of the presenters (good or poor) with 61% and 68% of accuracy, for eye contact and postures and body language criteria, respectively. Furthermore, the results suggest that a set of body language features, such as arms movement and smoothness, provide high significancy on predicting the level of development for presentation skills. The paper finishes with conclusions and possible paths for future work.

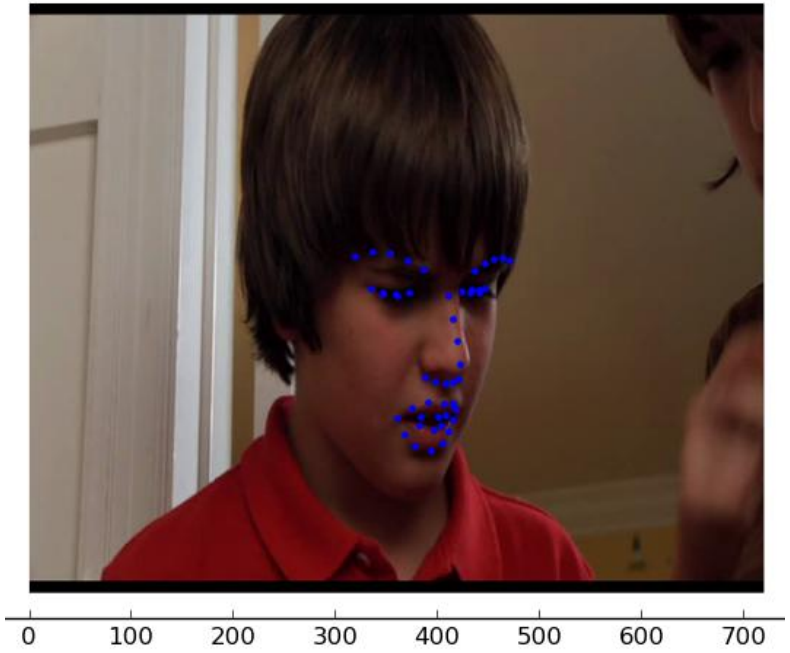
by business and industries; professional organizations and undergraduate program accreditation agencies (See [1], [14]). Instructors and students work hard to get evidence that demonstrate that students reach a desired level of effective communication. Evidences are constructed mostly in the interactions that take place during class time, practice sessions, etc. Precisely, these interactions are used by instructors to measure, assess and give on-time feedback about the development of such competences. However, this process is a time-demanding and complex task that needs dedication and experience on the side of the instructor. For instance, when instructors assess presentations, they need to be alert, about several verbal and nonverbal signals that happen in

Oral Presentation Quality Corpus



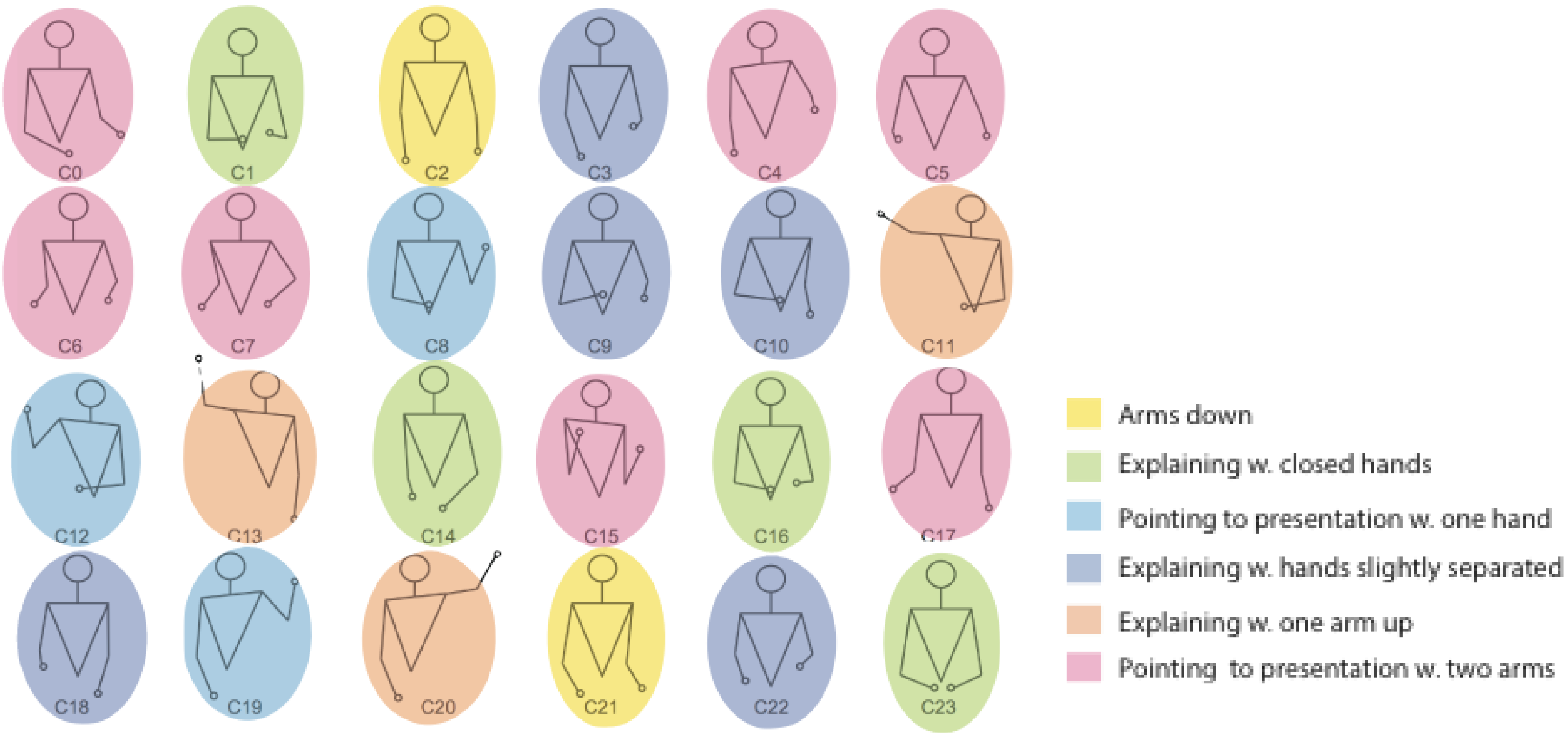
Video Features

- **66 facial features** were extracted using Luxand software including both **eyes** and **nose tip** to estimate the **presenter's gaze**.



Kinect features

- Identify Common postures

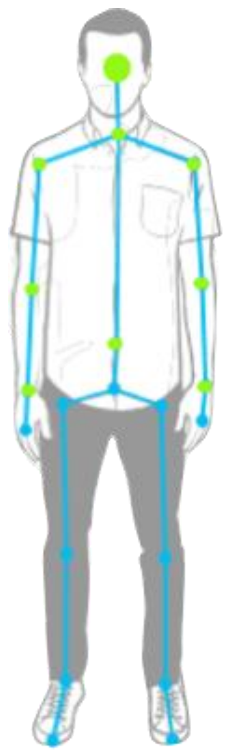


Kinect features

- Identify Common postures

Kinect Features

Laban’s theory helps to describe **human movement** using non-verbal characteristics:



- Spatial aspects of movement
- Temporal aspects of movement
- Fluency, smoothness, impulsivity
- Energy and power
- Overall activity

Extracted Features

Human coded Criterion

Video → **Eye Contact**

Kinect → **Body and Posture Language**

Results: less than 50% accuracy

What we were measuring was not was humans were measuring

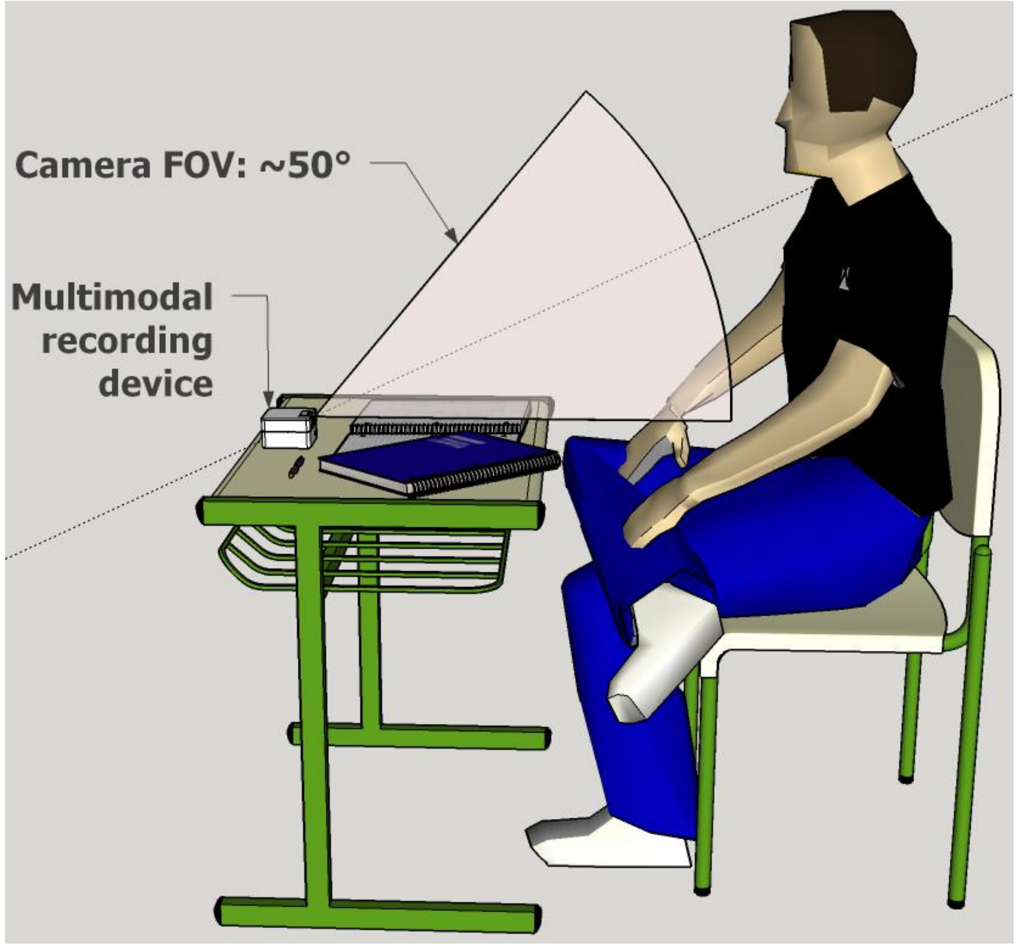
What is next in MLA?

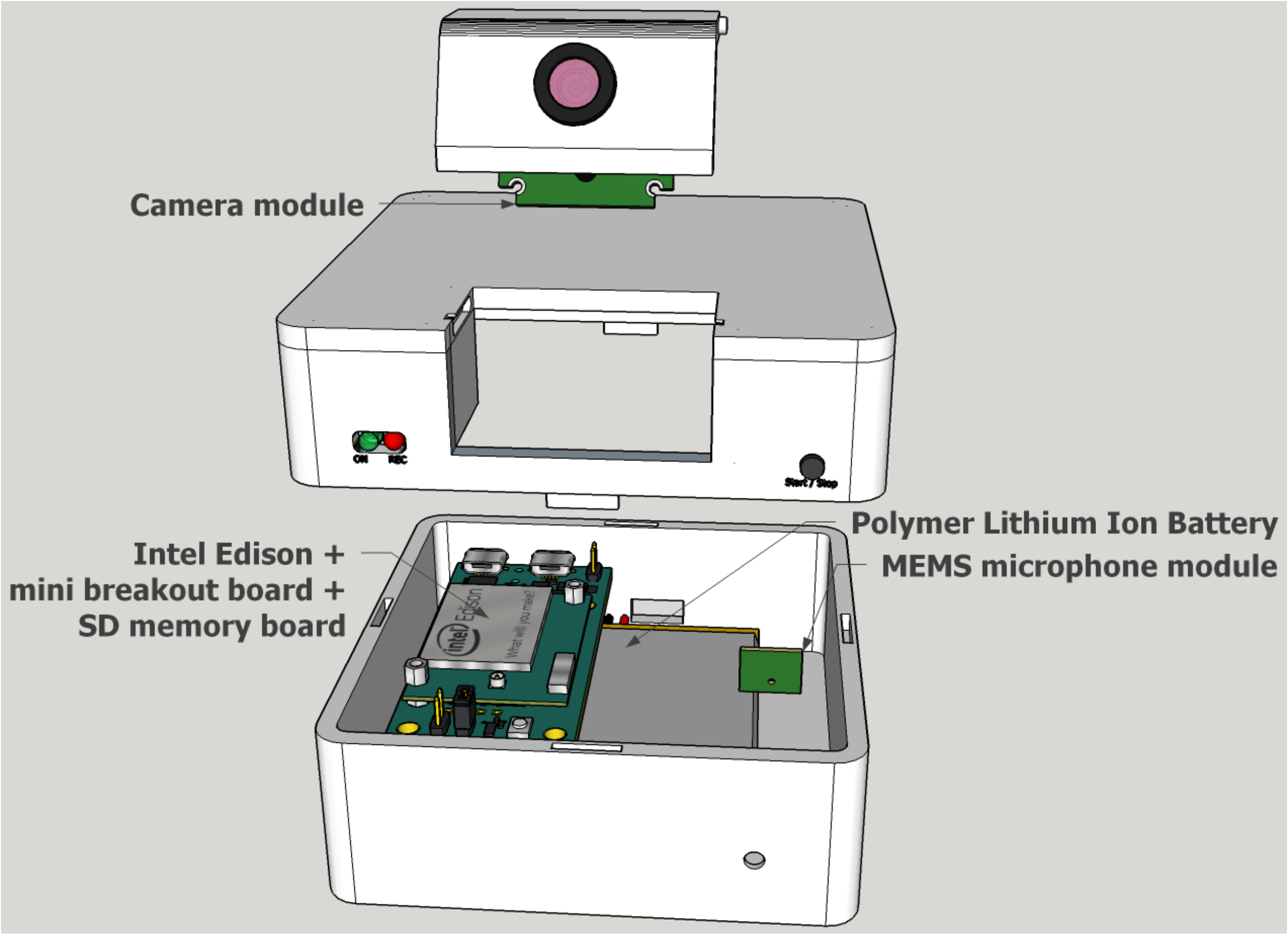
Mode integration framework for MLA

Currently pioneered by Marcelo Worsley

Developing
Multimodal Measuring Devices

Our Fitbits

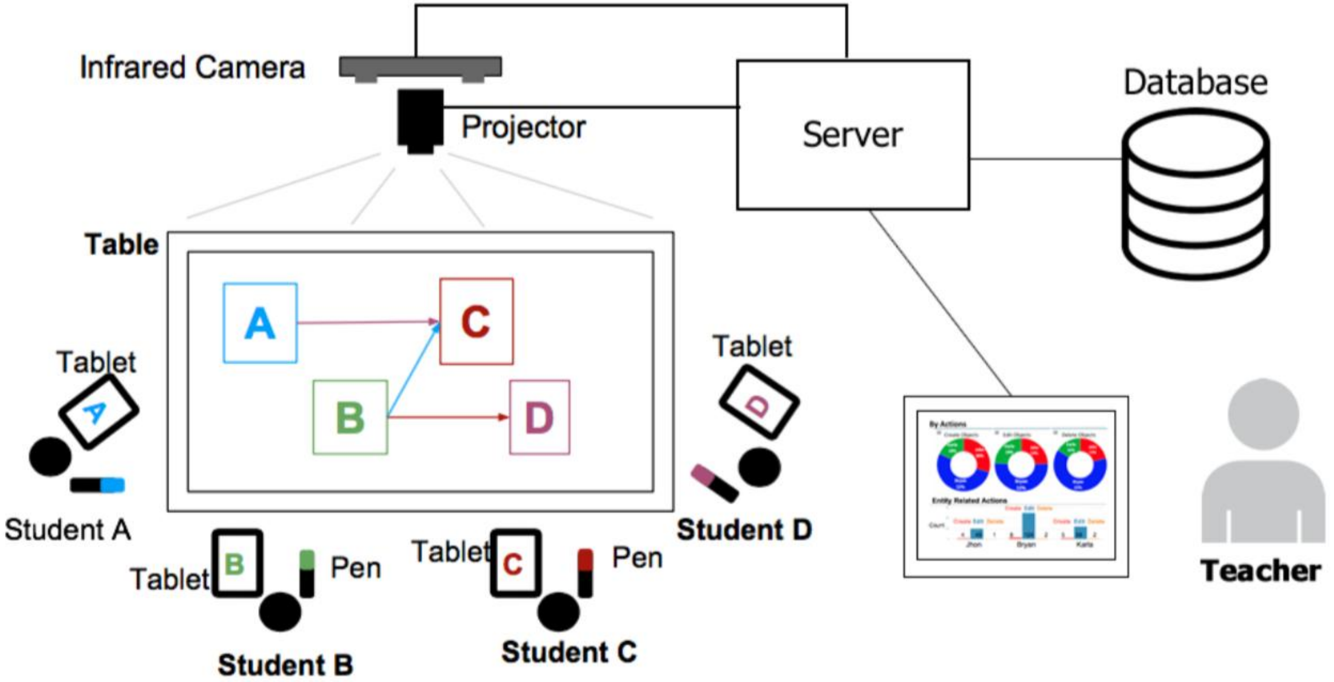

Camera FOV: ~50°
Multimodal
recording
device

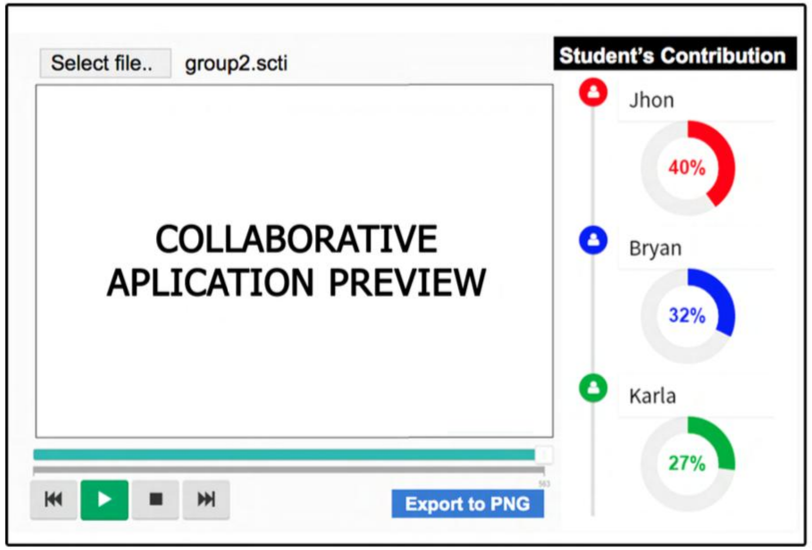

Camera module
Intel Edison +
mini breakout board +
SD memory board
Polymer Lithium Ion Battery
MEMS microphone module

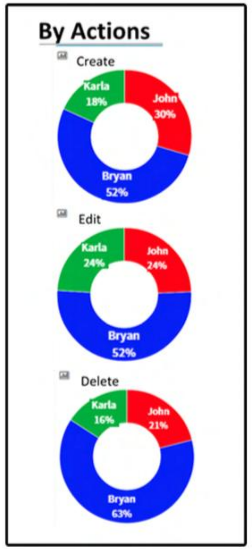

This is a test
This is cool
Hola amigo

Record different learning settings

And share them with the community

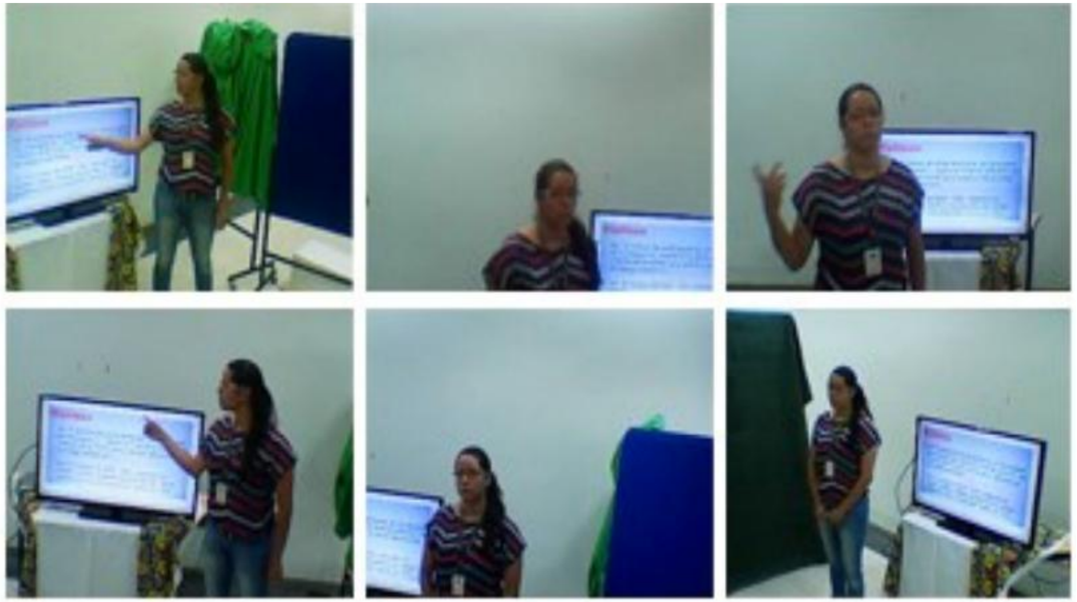


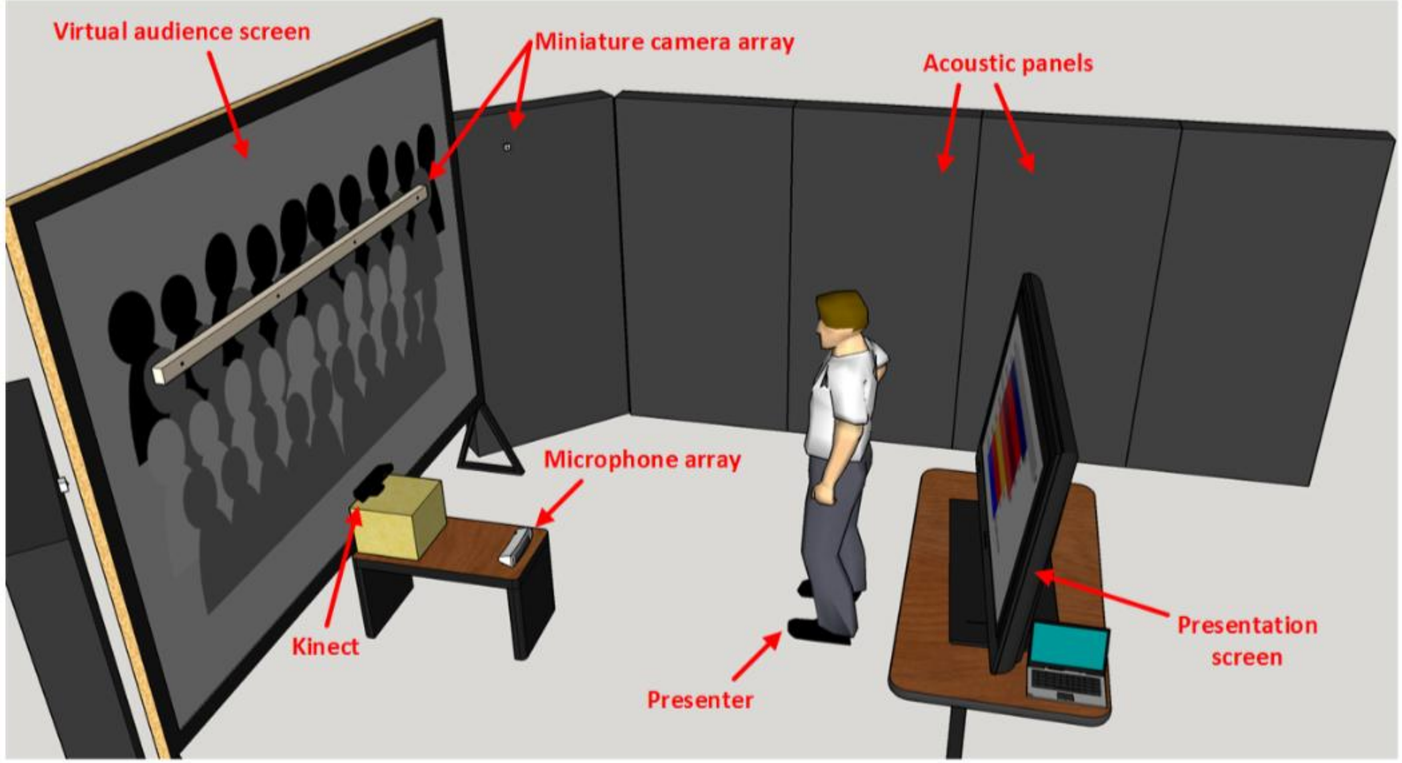




System to Support and Monitor Collaborative Design

Automatic Feedback for Oral Presentations



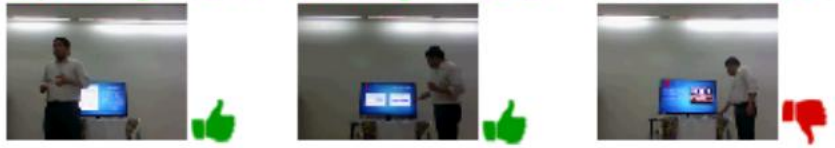


Audio analysis

You were talking fast with a few filled pauses.

Postures analysis

Explaining: 35% Pointing: 35% Arms down: 30%



Slides analysis

Good, you made a good job.

Slides:

1.- you should increase the font size.

More information review the link:

http://200.10.150.4/evaluator/a87d47e5d140e354aa6f30
82795dc5a2f2ef93059b842cea1f7265c5987560

Conclusions

Multimodal Learning Analytics is not a subset of Learning Analytics

Current Learning Analytics is a subset of MLA

☺

Some problems are easy, some hard

But we do not know until we try to solve them

There is a lot of exploring to do

And we need explorers

Interested?

Gracias / Thank you
Questions?

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http://ariadne.cti.espol.edu.ec/xavier
Twitter: @xaoch