Cultivating "trialogical", social-creative knowledge practices: Educational transformation at the digital age

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Salmela-Aro et al (2015) about 12-year-old-students

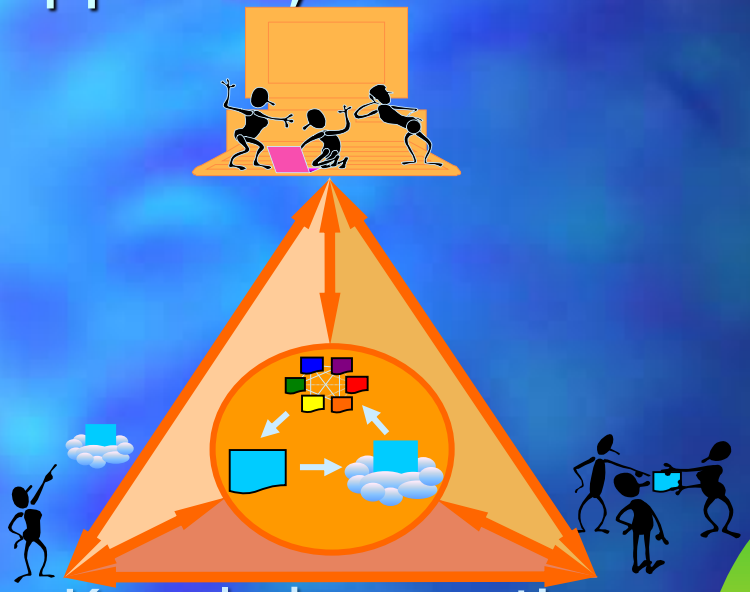
- Engaged (50%)
- Stressed (5%)
- Moderate cynicism (15%)
- High cynicism (5%)
- Emerging cyninism (26%)

The challenge of intellectual engagement

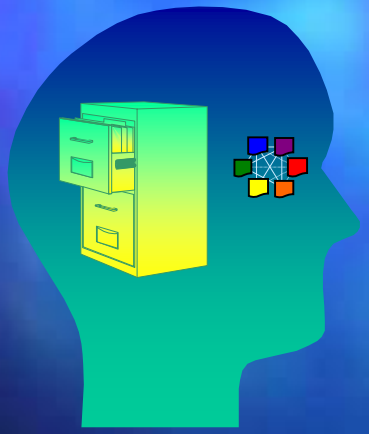
- Finnish students are performing very well in international school achievement tests
- Getting high science scores but indicating only a low interest in science
- Finnish students' level of liking school ranks only 60th of 65 countries
- Boys are bored/alienated and girls experience insufficiency/exhoustion
- Many students using ICTs actively have a cynical orientation toward school

Three metaphors of learning

(Paavola, Lipponen, & Hakkarainen, 2004)



Knowledge-creation metaphor (Pursuing engaging objects and projects trialogue)



Knowledge-acquisition metaphor (cultivated personal skills, monology)

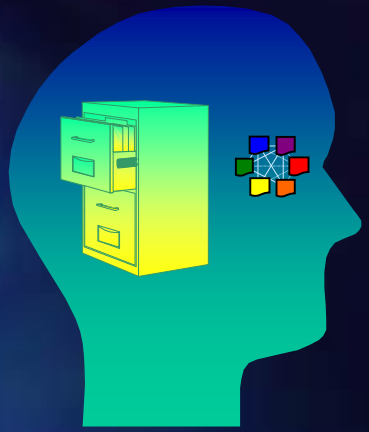
Participation metaphor (Sharing expertise in a valued community, dialogue)

Future requires innovation capabilities from everyone (Homer-Dixon 2001; Facer 2011)

Global changes	• Cumulated challenges and risks related to climate change, sustainability of Earth and radical inequality and the potentially emerging ”ingenuity gap” (limited collective inventiveness)
Societal changes	• Constantly transforming professional life necessitates life-long integration working and studying while many adolescents loose permanently interest in learning at school
Changing relations between education and work	• Unforeseen requirements of personal and collaborative knowledge and creativity require students to constantly stretch their capabilities: becoming ”shape-shifting portfolio people” (J. P. Gee)

Innovation and creative capabilities have to be cultivated from the very beginning of education

Generation 1: Inquiry learning



- Examining learning as knowledge-seeking inquiry (progressive-inquiry (PI) model)
- Showing that even elementary-school students are able to engage in a very advanced inquiry driven by their own questions and explanations
- Students follow their research questions, working theories interacting and sharing expertise
- Focus: how technology-enhanced learning elicits conceptual advancement and change within classroom

Progressive Inquiry Model (Investigative learning, Hakkarainen, 1998)

Investigative learning is a part of Finnish national curriculum guidelines

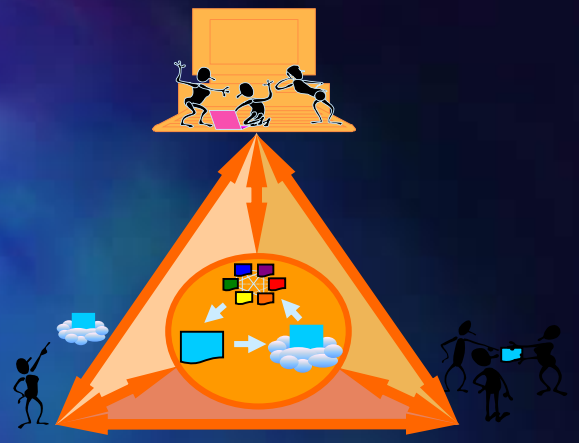
Generation 2: Social participation

- Analyzing (formerly invisible) classroom practices needed to make progressive inquiry to work
- Starting to videotape processes of teacher guidance (inquiry cultures capitalize on teachers' unaccounted invisible orchestration work)
- Analyzing patterns of participation in computer-supported learning by relying on social network analysis (from individual to relational phenomena)
- Extending studies to design of material artifacts
- Expanding the scope of investigations toward workplace communities (climbing out of the box)

Learning by Collaborative Designing (LCD) model

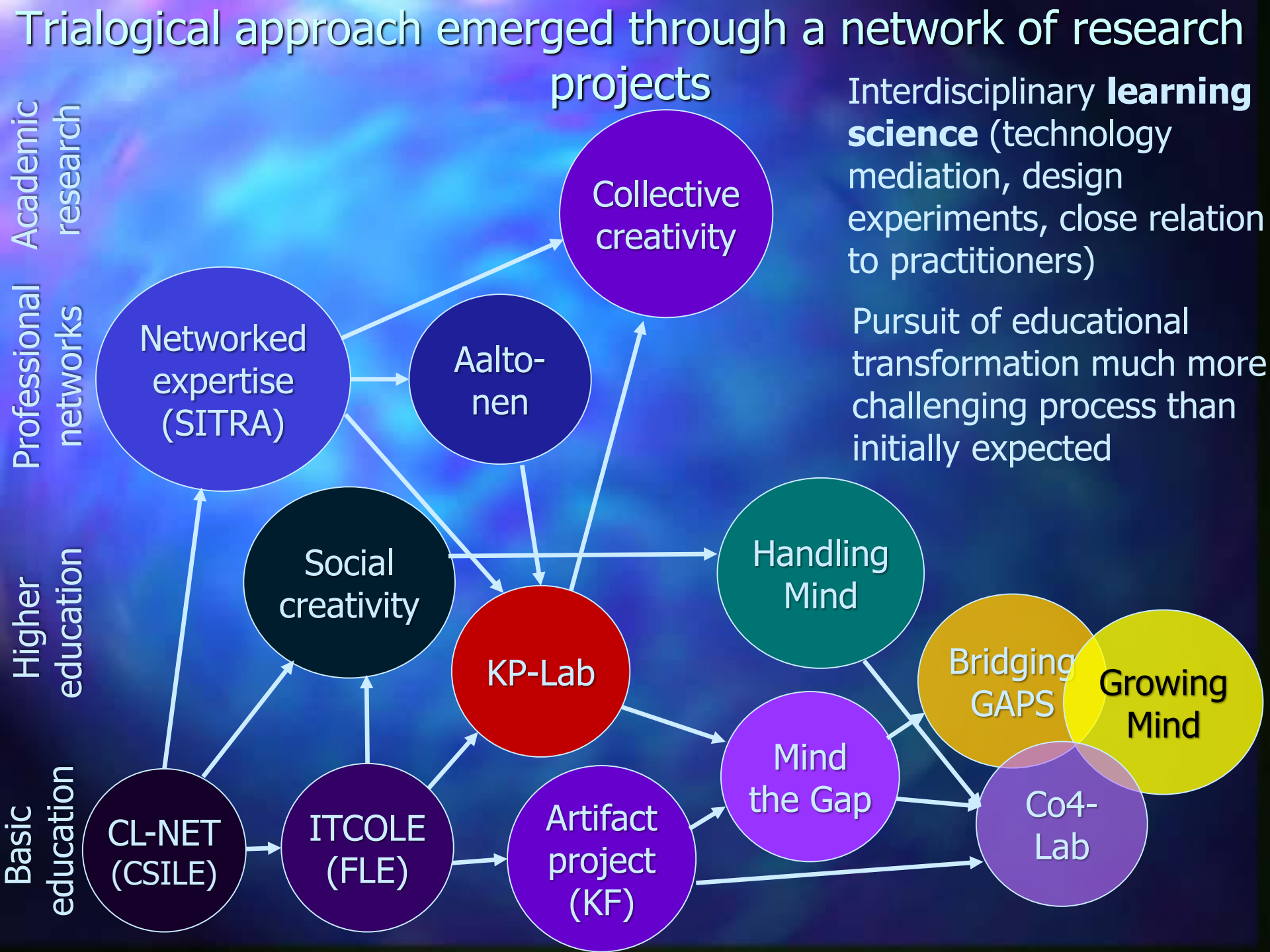
(Seitamaa-Hakkarainen, 2001)

Generation 3: Trialogical framework



- Participation in creating, sharing and advancing epistemic objects (problems, theories, artifacts, projects, practices) – incomplete but useful
- The trialogical approach foregrounds the **objective** aspect of learning allowing simultaneously to acknowledge both the **subjective** and **intersubjective** ones.
- Evolving framework for examining knowledge-creation processes in **educational** and **professional** contexts (including academic research as **networks of creative projects**

Trialogical approach emerged through a network of research projects

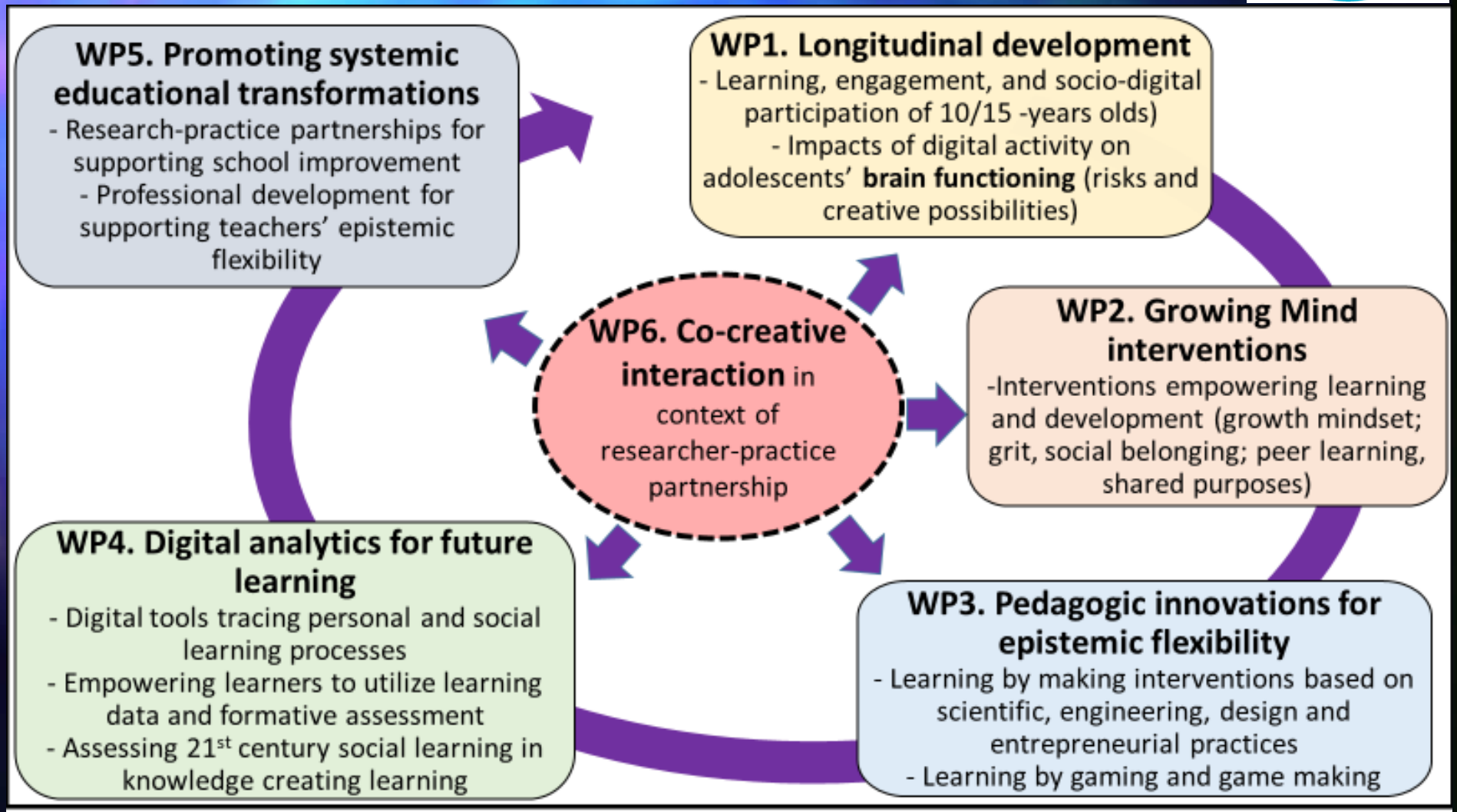


Interdisciplinary **learning science** (technology mediation, design experiments, close relation to practitioners)

Pursuit of educational transformation much more challenging process than initially expected

Growing Mind: Personal, social, and institutional renewal at the digital age

(Strategic Research Programme of the Academy of Finland (2018-2023)



Multi-disciplinary network of educational research, craft science, developmental psychology, computer science, game studies, and neuroscience

Digital natives from the beginning of their lives cognitively socialized to use socio-digital technologies for thinking and interaction

Digital immigrants, in contrast, use socio-digital technologies as weakly integrated exter-nal tools

THE SHALLOWS

- Intensive but meaningless use of ICTs may create shallow ”grasshopper” minds unable to reach in-depth learning and understanding
- Intensive multi-tasking in terms of using multiple media simultaneously appears to corrupt capabilities of sustained attention (Mind the Gap, Moisala ym. 2016)
- Simultaneously, digital gaming develops working memory capabilities (Moisala et al 2016b)

Three practices of using digital technologies (Ito)

Creative Participation Gap (Jenkins: Disadvantaged students have limited digital access, addict to shallow digital practices and have no support for creative use of technology

Trialogical practices of using digital technology practically missing from Finnish schools!

Friendship-driven use of technology. Hanging out by keeping hyperintensive connection with extended network of friends through texting, instant messaging, and emailing mediated by mobile devices and social media.

Interest-driven use of technology. Using socio-digital technologies for pursuing interests, such as seeking knowledge, sharing hobbies, using and creating media, and developing technological competencies

Creative educational use of technology. Advanced practices of using socio-digital technologies for solving complex problems, creating and building knowledge and artifacts and, preferably, pursuing long-standing ”trialogical” study projects

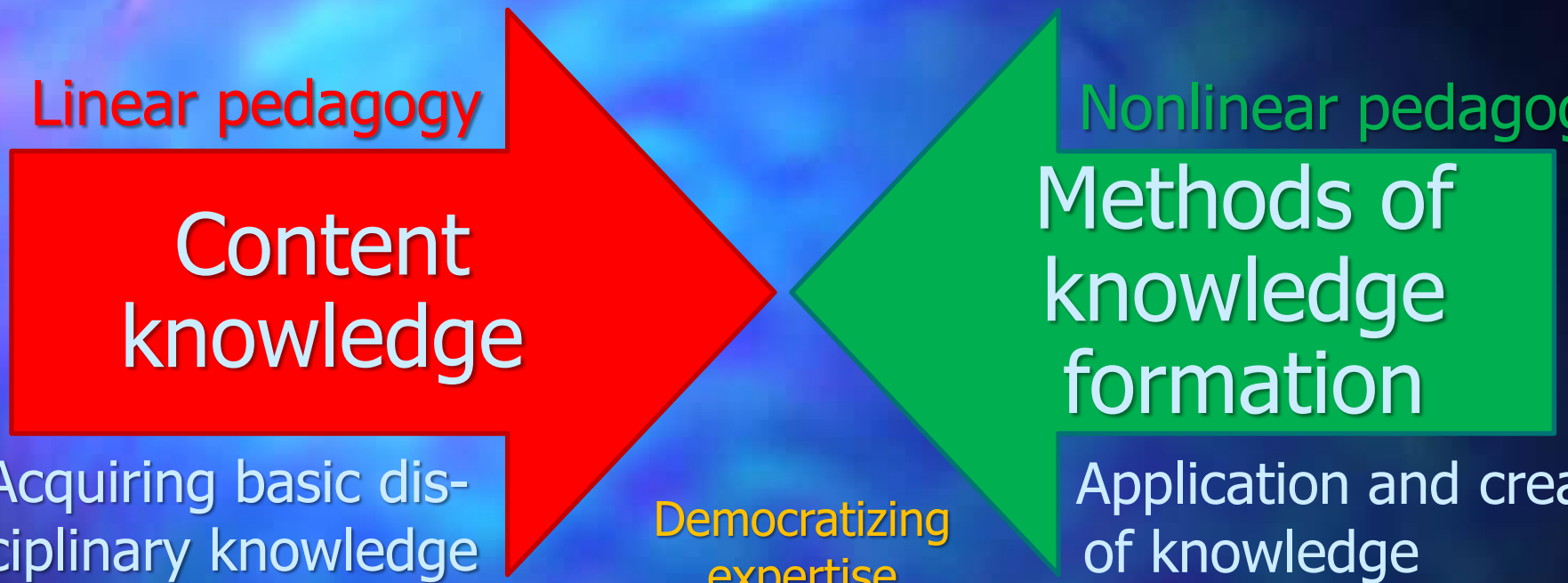
Pedagogies of trialogical, knowledge-creating learning

Traditional learning	Knowledge-creating learning
Simple, closed problems	Complex (real-world) challenges
Tasks related to a lesson or textbook	Spatio-temporally extended efforts
Reproductive assignments	Building knowledge creating artifacts
Individual assignments	Social learning, peer collaboration
Within school tasks	Boundary breaking projects

Investigative learning, inquiry-learning, project-based learning, learning by design, maker-centered learning, creative game-making)

Without supporting school culture even the best students pursue reproductive practices of learning

Toward knowledge-creating learning



Acquiring basic disciplinary knowledge

- Focus on simplied and outdated textbook knowledge
- Becomes rapidly obsolete
- Content without methods looses its meaning (intert knowledge and routines)

Democratizing expertise

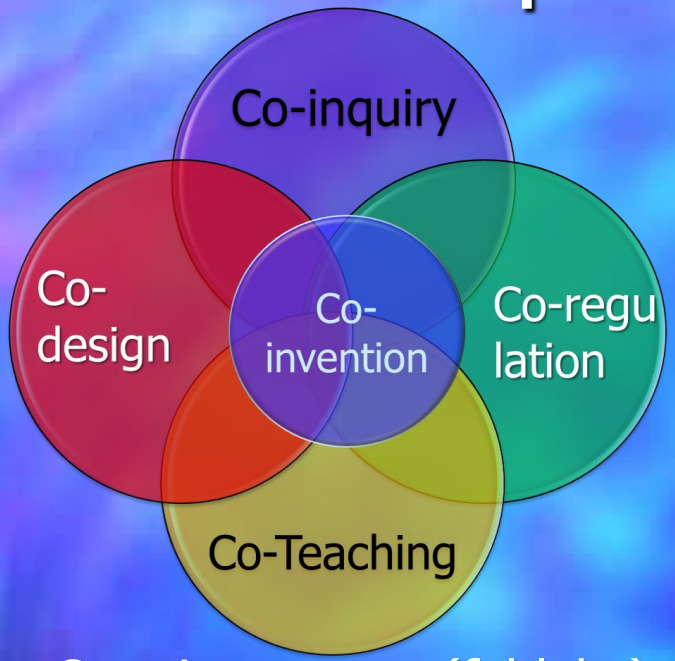
Application and creation of knowledge

- Inspiring real challenges
- Scientific, engineering, design and entrepreneurial practices
- Sharing expertise in collaborative pursuit of challenges

Phenomenon-based approach on learning

- Cross-cutting study projects for bridging isolated disciplinary silos and integration of knowledge
- Each year a cross-disciplinary project for investigating complex real-world phenomena (e.g., life and death, poverty, climate change; human and technology)
- Empowering students to design curriculums
- Challenging teachers to go beyond their comfort zones
- Fostering multi-professional teacher collaboration
- Networking with cultural communities beyond school

Invention pedagogy: Co4-Lab



- Bringing elements of maker culture to school in terms of challenging knowledge-creation projects
- Engaging students co-designing and co-constructing complex artifacts sparking intellectual, engineering, and aesthetic challenges
- Operational methods of creative making that provide access to experts methods, practices and networks

- Creating spaces (fablabs) for making and inventing at school
- Complex invention projects supported by traditional and digital fabrication technologies

Ethos:

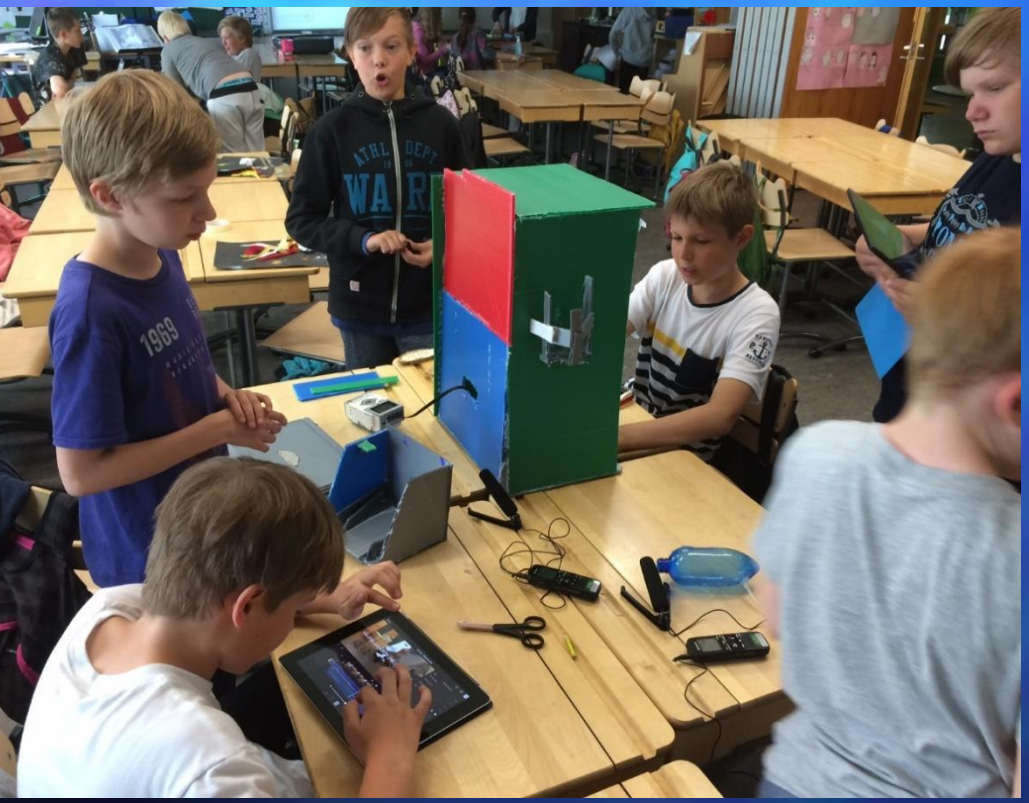
- Everybody can be an inventor
- Best ideas are co-created
- Ideas develop by exploration
- Inventing requires sustained effort across iterations

Open frame of Co4-Lab projects

Orientation	Analysis of various artifacts, their history and features
Design challenge	An invention and design challenge (investigating earlier designs and their users)
Co-Inquiry	Exploring and testing ideas through science experiments
Ideation	Producing design ideas and analyzing design constraints
Exhibition	Presenting ideas and getting feedback from peers, teachers, and experts
Knowledge seeking	Knowledge seeking from museums, internet, joint field studies
Co-Inquiry	Testing design ideas, creating mock-ups and prototypes
Fabrication	Fabricating models and products
Exhibition	Introducing and publishing inventions and reporting knowledge creation processes

Examples of co-invention projects

The given design challenge was very broad and included only one requirement: "It could be a new or improved innovation and it should integrate material and digital (e.g. circuits or robotic) elements."



Snack Machine

Gel comb

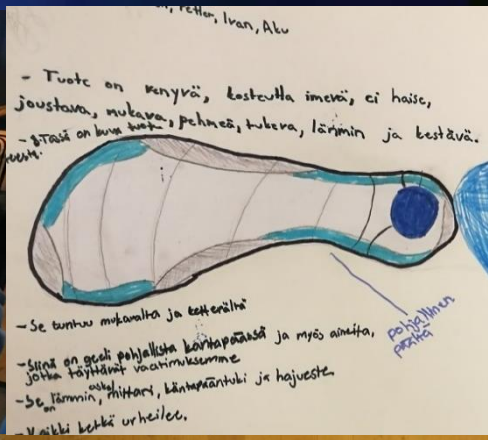
Little Thinks mobile application

Food waste minimizer/fridge aid

For who?	For families, for all
For what?	It shows the content of a fridge and tells you what you need to buy more.
How?	A display shows an animation of the fridge's content. It shows which products are about to expire and which are running low (a red light and a sound).
The Look	It is shaped/sized like an iPad. It has magnetic covers to keep it attached to the fridge.
Construction	Magnet. iPad, screen, electricity, internet, plastic.

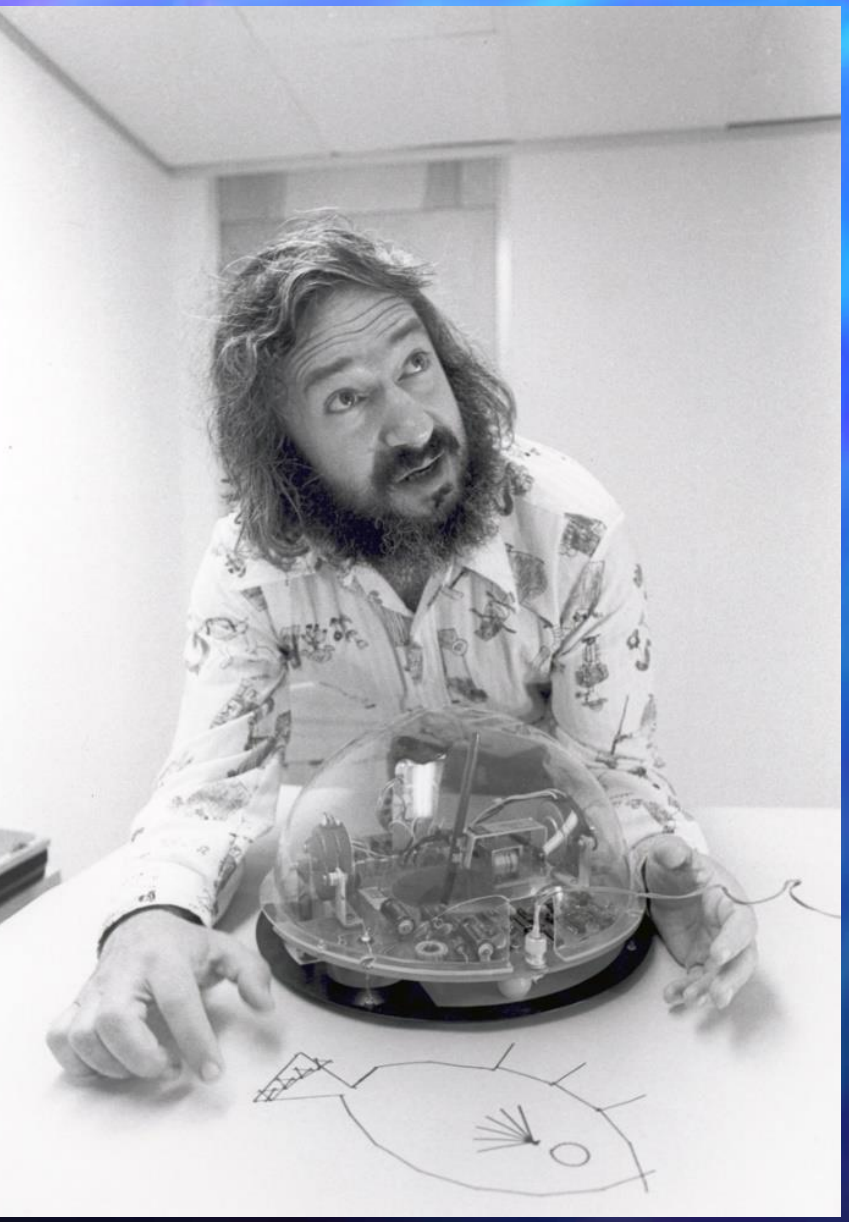
UrPo

Smart insoles for sport shoes



Teacher students orchestrating maker projects at schools when doing their practical training

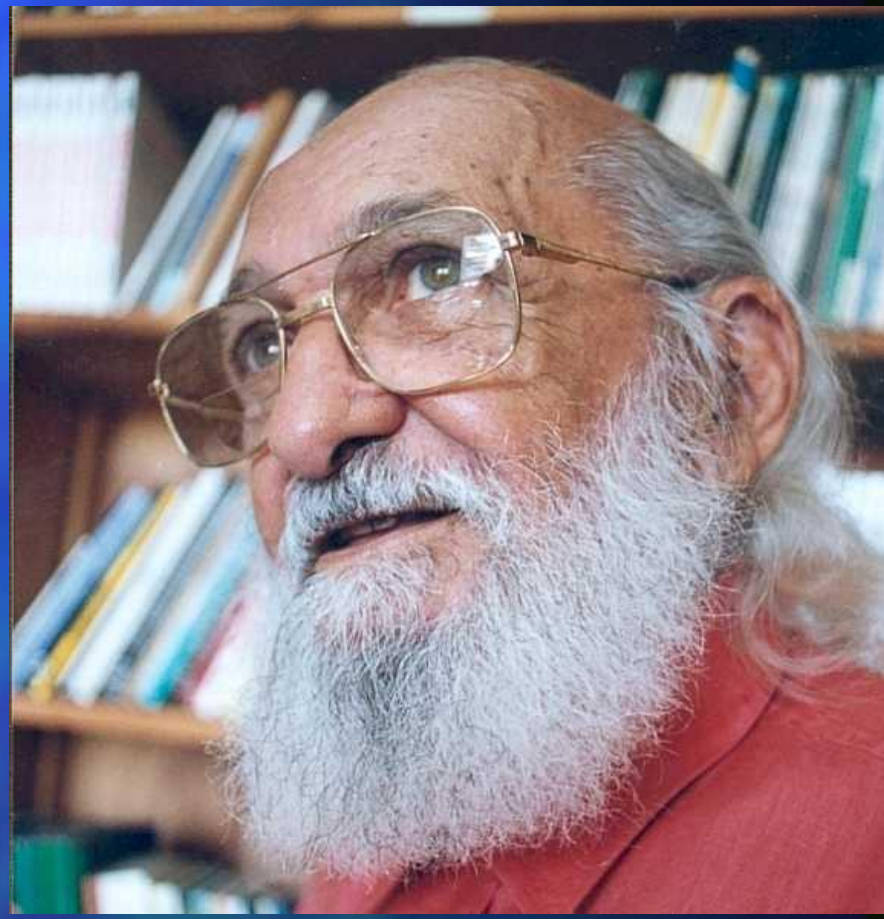
Manifest of maker-centered learning



- Making and creative expression are a part of human nature
- When sharing products of our making, we feel whole (mattering)
- When sharing products of making, humans give a part of themselves
- Making requires and facilitates multi-faceted and rich learning
- Making requires sophisticated instruments and practices
- Creative making is playful
- Make culture invites open participation of diverse learners
- Making requires guidance/support
- Making elicits human growth

Paulo Freire and learning by making
(Paulo Blikstein, Stanford University)

- From "consciousness of real" to "consciousness of the possible"
- *"When men and women perceive themselves as makers of culture, we can declare [as] taken the first step for them to feel the importance, the need and the possibility to learn reading and writing. They are already literate, politically speaking."*

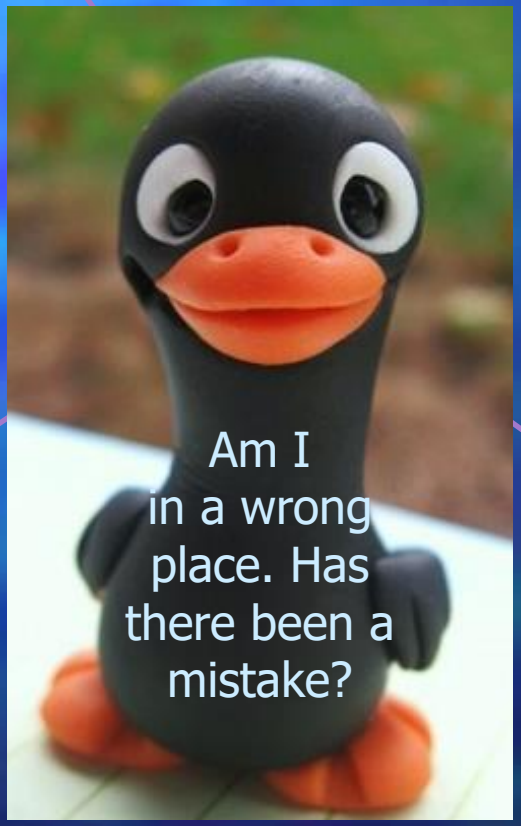


A genuine sense of contribution inflames learning and development

Distributed agency (47%)

- Collective efficacy, social sharing of expertise and merging efforts

Surpassing oneself presupposes three complementary forms of agency (Hakkarainen et al., 2014)



How to overcome insuperable learning challenges

Personal agency (32%)

- Personal efficacy, strengths and expertise

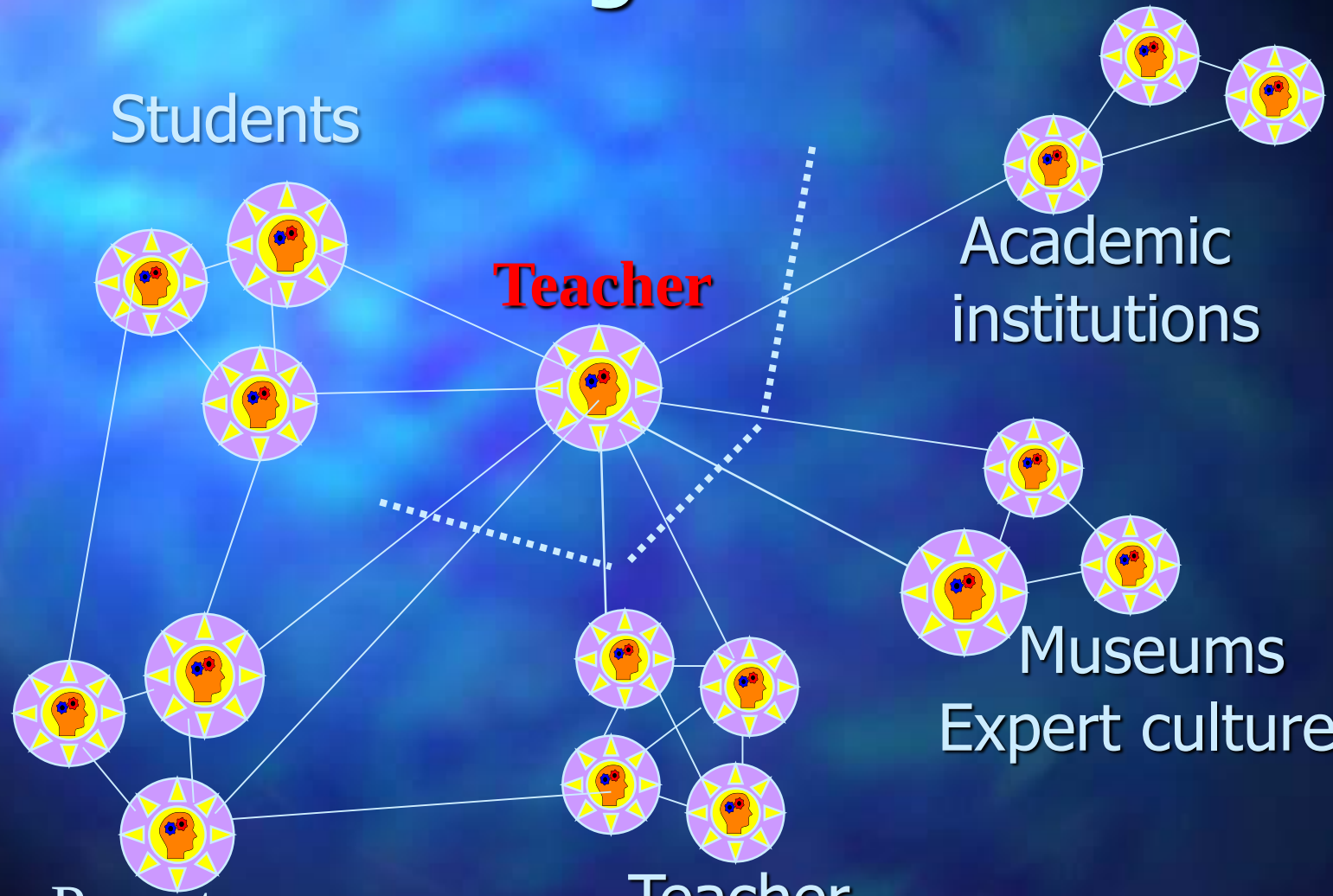
Objective agency (21%)

- Object-oriented interagency, transactive growth of capacity

Teachers' critical role in invention pedagogy

- Teachers are hearts and souls of knowledge-creating learning
- Learning to guide nonlinear pedagogic processes
- Flexible orchestration of learning across short and long terms
- Engaging in practices of co-teaching (professional collaboration)

Building an extended professional learning network



Research-practice partnership

- Socially robust knowledge needed for school improvement can only be created in interaction with teacher practitioners
- Working at the field inspire academic research and requires adapting investigations to practicalities of schools (e.g., practical measures)
- Collaboration with researchers give teachers new perspective and foster professional development

- Without researchers' support teachers tend to reduce disruptive digital innovations to ones sustaining prevailing educational practices

Global citizenship education and trialogical learning

- Natural contexts for building school-community relations (engaging parents and other community members in creative school projects)
- Engaging school in community development efforts by addressing vital local societal problems
- Providing a sense of mattering for students by creating tangible objects, such as artifacts and services, that have meaning beyond school studies
- Working with shared objects assists in building a coherent learning community across diverse groups of students (school achievement and cultural differences); diversity as a resource
- Pursuing joint objects in teams make students positively interdependent (mere dialogue may not be enough)

Developing smart schools of future

1. Making schools as innovative knowledge communities that use research-based inno-vations to systematically improve their practices
2. Engaging students in challenging "trialogical" study projects that involve creation of new knowledge and artifacts

Linear vs nonlinear pedagogy

Linear

1. Goals are predetermined and given
2. Knowledge content fixed (pushing knowledge)
3. Methods and stages of activity are pre-given
4. Activity is highly scripted even if some improvization
5. Activity context within educational institution
6. Summative evaluation and possible formative elements
7. Only teacher functions as a progressive problem solver

Nonlinear

1. Goals are open and partially unforeseen
2. Knowledge content open and expanded (pulling knowledge)
3. Methods and stages of are envisioned but may transform
4. Activity is emergent but flexibly structured
5. Activity context expands beyond educational institution
6. Formative and developmental assessment necessary
7. Everybody has to participate in progressive problem solving (”creative failure”)

Emerging possibilities of educational use of socio-digital technologies

1. generation

Technology -push model

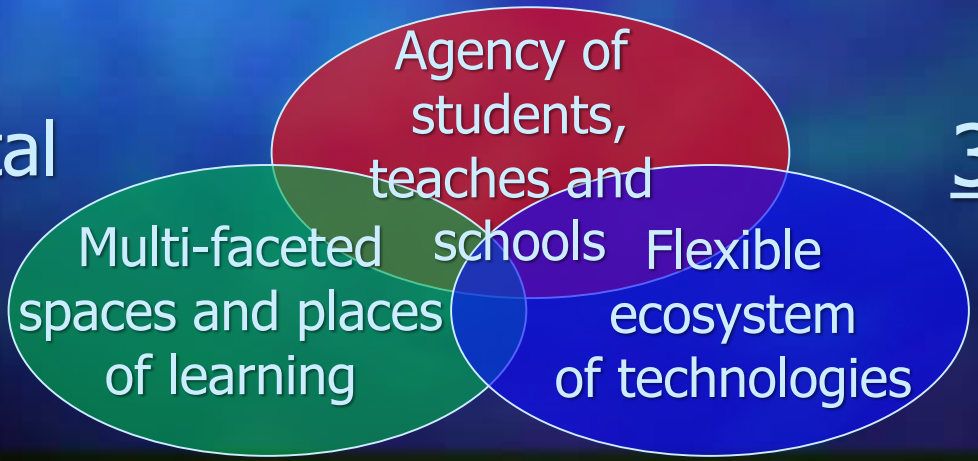
Technology → School

2. generation

Research-centered model

Technology → Learning environment research ↔ School

Socio-digital ecology model

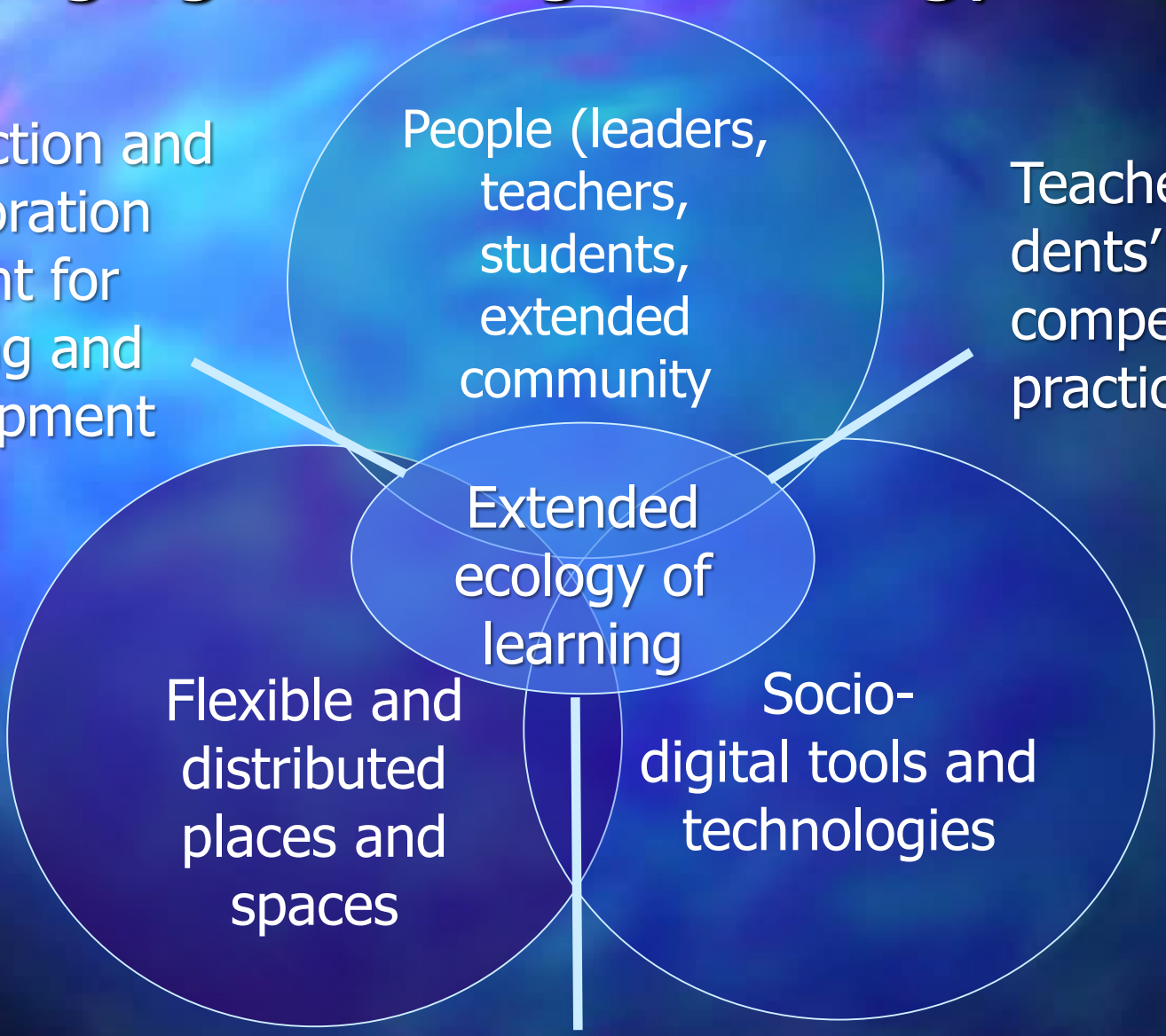


3. generation

- Democratizing innovations
- Co-configuration of interventions

Emerging socio-digital ecology of learning

Interaction and collaboration relevant for learning and development



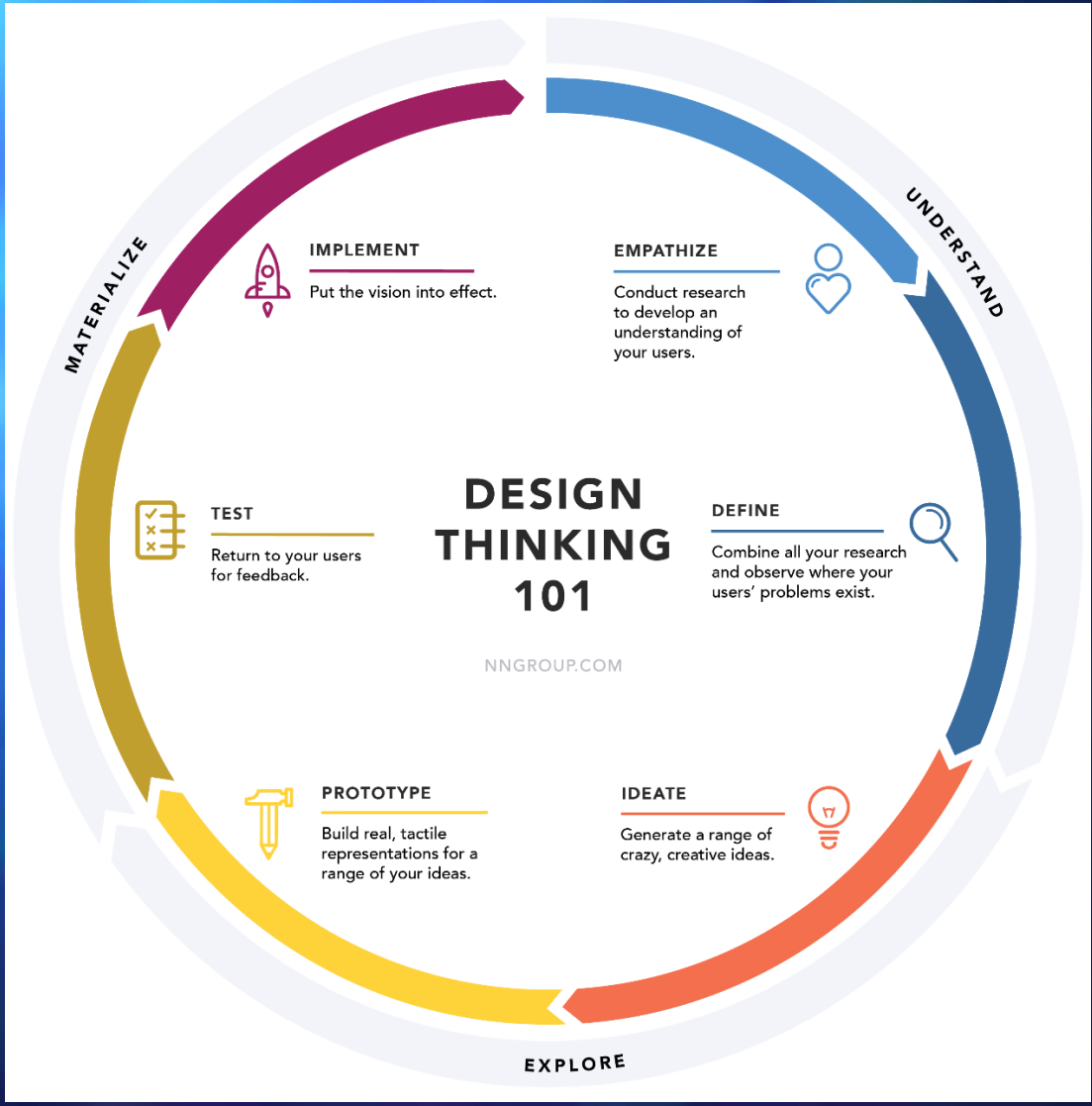
Teachers and students' socio-digital competences and practices

=> Radical redesign of school environments

Locally emerged distributed innovative knowledge and media practices (knowledge practices)

Design thinking: designing solutions to local or broader societal problems

Social design experiments: co-designing solutions and testing them in practice together with community participants



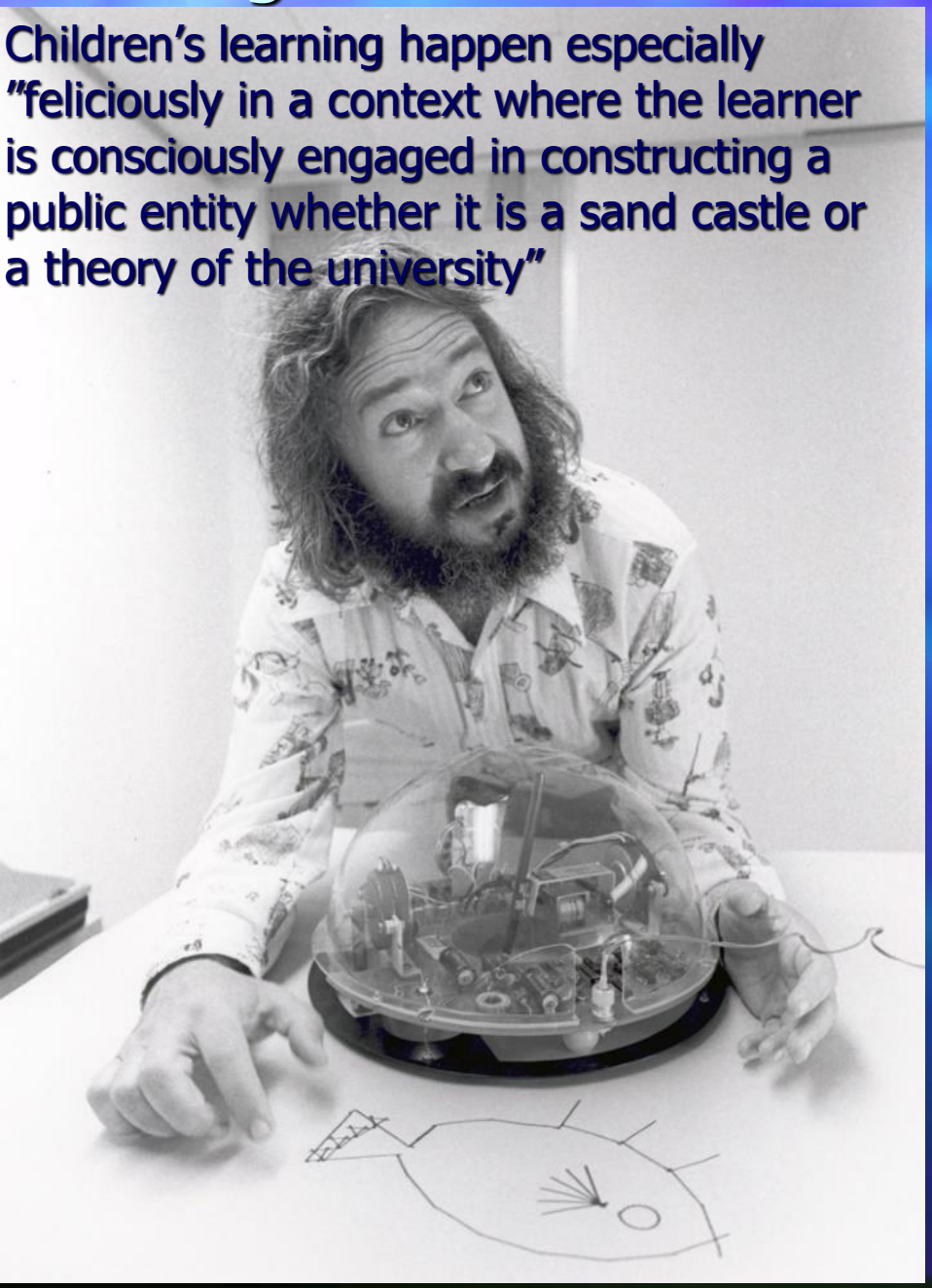
Challenges of integrating digital technologies with educational practices

- After 20 years of efforts, digital technologies did not root as a part of Finnish schools.
- Digitalization of **the matriculation examination** has changed the situation considerably
- **Emerging socio-digital ecology** (Mobile and wireless technologies, thousands of adaptable applications, new generation of teachers, and new institutional commitment
- Schools tend to reduce new (**disruptive**) innovations to ones **sustaining** their prevailing practices (research-practice partnership)

School improvement requires **research-practice partnership** aimed at cultivating new practices of working with knowledge and media (**knowledge practices**)

Trialogical framework inspired by Seymour Papert

Children's learning happen especially "feliciously in a context where the learner is consciously engaged in constructing a public entity whether it is a sand castle or a theory of the university"



- Artifact-mediated thinking inflames learning
- Improvizational exploration opens up new pathways of learning
- Artifact-mediated interaction fuses students together
- Artifacts may become internal and external tools of thinking
- Creation of artifacts provides sense of contribution
- Building identity as pros-pective creator of knowledge

YRITYSAMIS

- Touching example of entrepreneurial renewal of vocational education that inflames students' learning and teachers' professional development
- Working in enterprise-like customer projects
- Teacher as team coaches
- Learning content in context
- Working constantly in teams
- Monthly celebrations of student achievements

Kainuun ammattiopisto on Suomen PARAS

Kainuun ammattiopisto

YritysAmis

KULTTUURI LUONTO LIIKETALOUS

Radical change in operational culture of vocational education
An educational institution becomes a driving force of innovation and transformation

Gamification and creative game making (game jams)

Frans Mäyrä's centre of excellence regarding game studies

- **Game Jams:** Intensive working (48h) in a collaborative space for co-designing and creating a new game (students, avid gamers, game researchers)
- **Teacher game jams:** Professional development workshops that involve hands-on learning of ludic learning, exploring educationally relevant games, reflecting on their pedagogic use and co-designing learning-by-gaming projects

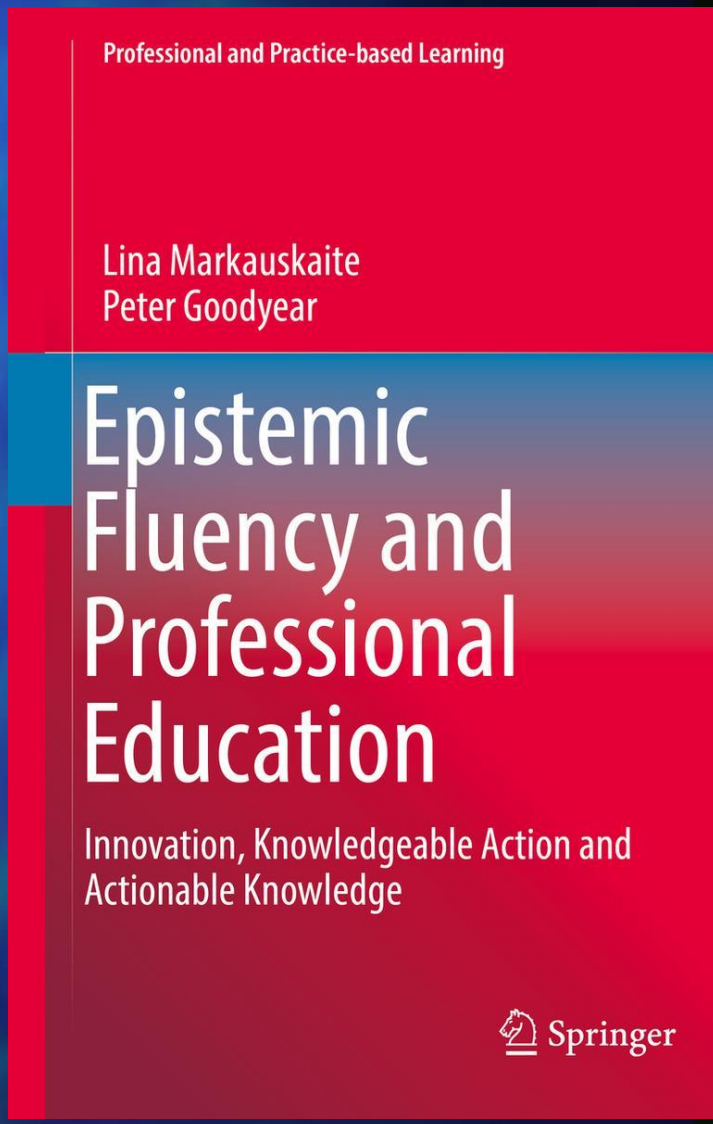
FINNISH GAME JAM

MAKE GAMES - CHALLENGE YOURSELF

Epistemic flexibility (fluency)

(Markauskaite & Goodyear 2017)

- **Student's epistemic flexibility:** knowledge practices that enhance capability to integrate formal and informal knowing in solving complex open-ended problems
- **Teachers' epistemic flexibility:** capability to orchestrate nonlinear, open-ended and inventive study processes rather than highly scripted, closed and reproductive learning tasks.
- Cultivate operational competences that inventive **epistemic games** (investigative learning, knowledge building, learning-by-making) require in rapidly changing innovation society



Professional epistemic cultures

Knorr Cetina & Reichmann; Jensen, Lahn, Nerland)

- Epistemic cultures are cultures of using, creating, and warranting knowledge (how do we know what we know?
- New knowledge practices needed because:
  1. Constant encountering of novelty without established practices or standards
  2. Conflicting knowledge claims that arise uncertainty and disturb work
  3. Knowledge processes become a visible aspects of everyday working

- Creative, transformative and dynamic knowledge practices for overcoming unforeseen problems and challenges

Sosial work, engineering teaching

Teachers' new epistemic professional culture

Teachership in uncertain, complex and turbulent knowledge society

What is trialogical learning?

- Trialogical learning is an approach based on third, **knowledge-creating metaphor of learning** (beyond knowledge –acquisition and participation ones).
- **The focus of trialogical learning is a collaborative effort of advancing shared knowledge artefacts in long-term processes.**
  - Object-orientedness (object-centered approach on learning)
  - Long-standing pursuit of knowledge advancement
  - Interaction between individual and collaborative efforts
  - Cross-fertilization of knowledge practices
  - Development through transformation and reflection (co-evolution of artefacts, practices, and agents)
  - Multimediation of trialogical learning processes (epistemic, pragmatic, social, reflective)
- **A metalevel framework** that can be utilized for ”trialogicalization” of traditional pedagogical models (i.e., promoting features of PBL, KB, LBD that involve a stronger knowledge-creation element)

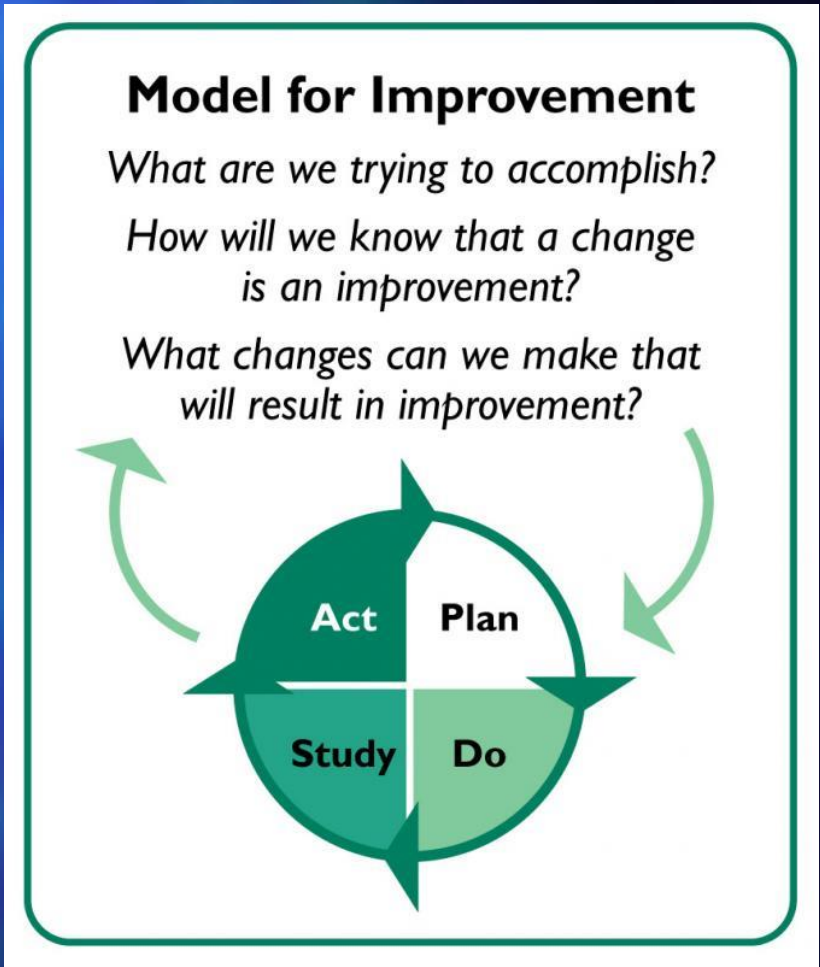
Trialogical inquiry

- An instantiation of pedagogical models based on the trialogical approach
- Work-in-progress and in need of improvement
- Based on **expansion of progressive inquiry (PI model)** in terms of
  - Putting object-oriented inquiry in the centre
  - Highlighting pursuit of complex problems (complexity of which come from outside of an academic institution)
  - Pushing students to stretch their understanding by posing questions and working theories
  - Engaging students in field studies and other investigations that elicit cross-fertilization of knowledge practices
  - Integrated focus on knowledge advancement and practice transformation
  - Facilitating user evaluation of knowledge artefacts generated

Improvement science

(Bryk et al., 2015; Coburn & Stein, 2010; Fishman et al., 2014; Penuel et al., 2011)

- Practice-driven educational improvement science guides systematic participatory transformation in research-practice interaction
- At pilot schools, we decide small changes to be tested, define necessary steps, determine measures of success (Plan); implement the plan (Do), collect data to test predictions (Study), and determines the next changes (Act).
- Analyzing variation in performance regarding digital learning/teaching, nonlinear pedagogy, epistemic flexibility and collaborative learning



Expanding improvement science from health care to educational system.

Six principal features of trialogical inquiry

1. Focus on shared object of activity
2. Sustained and longstanding pursuit of knowledge advancement
3. Interaction between personal and collective activities
4. Cross-fertilization of knowledge practices between educational, professional and research contexts
5. Technology mediation fostering longstanding creation, sharing, and advancement of knowledge
6. Development through transformation and reflection (conversion of levels of knowledge, deliberate transformation of practices)

Sustaining versus disruptive innovations

Christianssen)

Sustaining innovation	Disruptive innovation
▪ Problems in the field well understood ▪ Support prevailing practices ▪ Incremental improvement ▪ Satisfies currently experienced needs ▪ Effects of activity predictable ▪ Traditional approaches are sufficient	▪ Emerge new weakly understood problems ▪ Create gradually new practices ▪ Dramatic changes (game-changing) ▪ Satisfies not yet identified future needs ▪ Effects of activity unpredictable ▪ Traditional approacheds and methods fail

School institutions tend to reduce radical innovation possibilities to ones sustaining prevailing (teacher-centered and reproductive) practices => importance of research-practice partnership

Finnish basic education

National Board of Education

High standards for all

Encouraging, enabling

Learning culture

Ethos of trust

Professionalism of teachers

Empowerment of teaching profession

High quality teacher education

Supportive ethos

Early intervention

Personalized approach

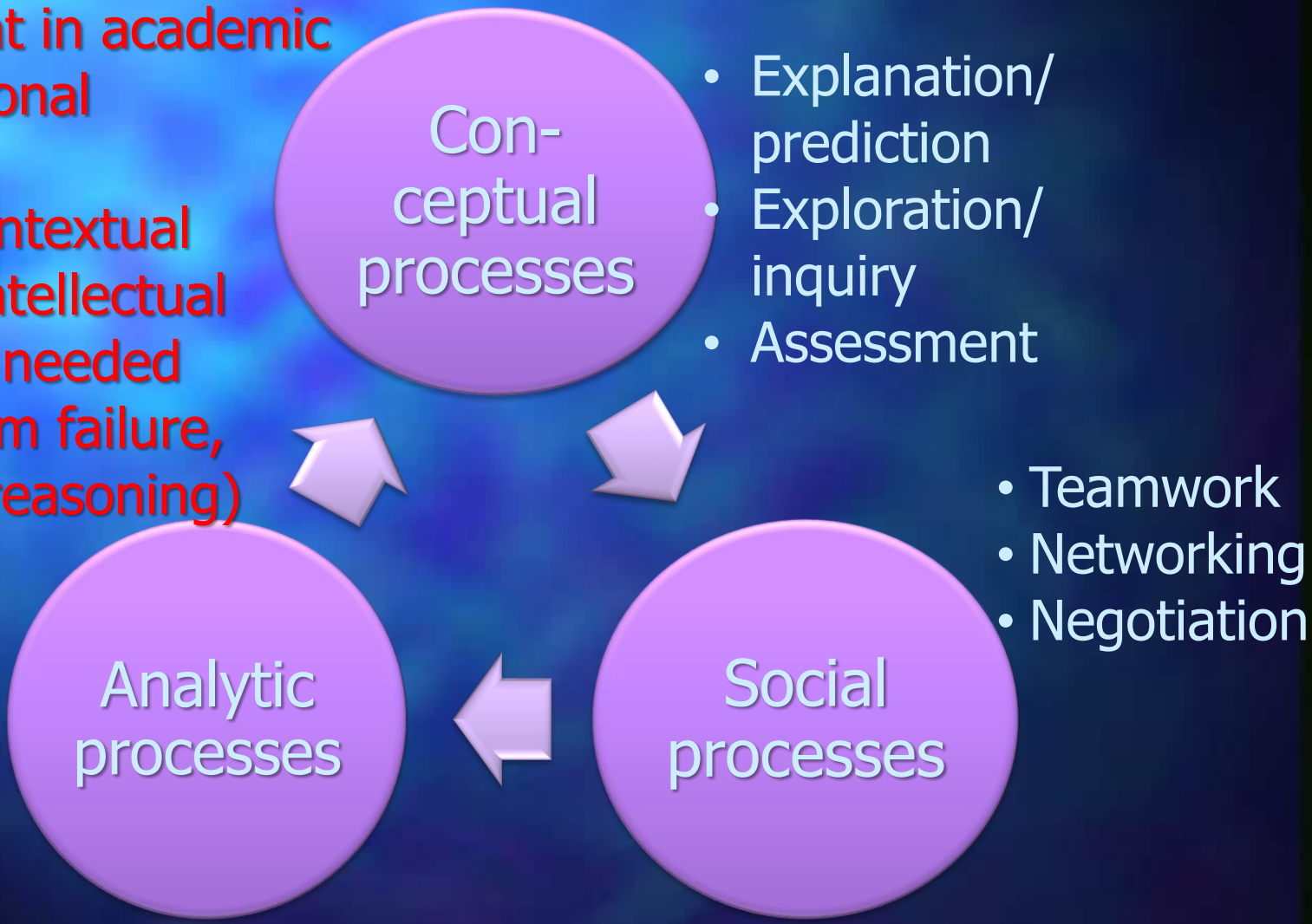
Active role of students

Education system:

comprehensive, non-selective, central steering, local implementation and innovation

Teaching intellectual processes ("Teaching Minds" Roger Shank, 2011)

- The same intellectual processes are important in academic and professional education
- Repeated contextual practice of intellectual processes is needed (learning from failure, case-based reasoning)



Epistemic mediation

(working with knowledge artifacts)

knowledge work

Reflective mediation

(Making visible, reflecting on and transforming practices)

Metawork

Inquiry is always **multimediated** process

Inspired by Pierre Rabardel & Göte Nyman)

Social mediation

(Collaborating, building networks)

people work

Pragmatic mediation

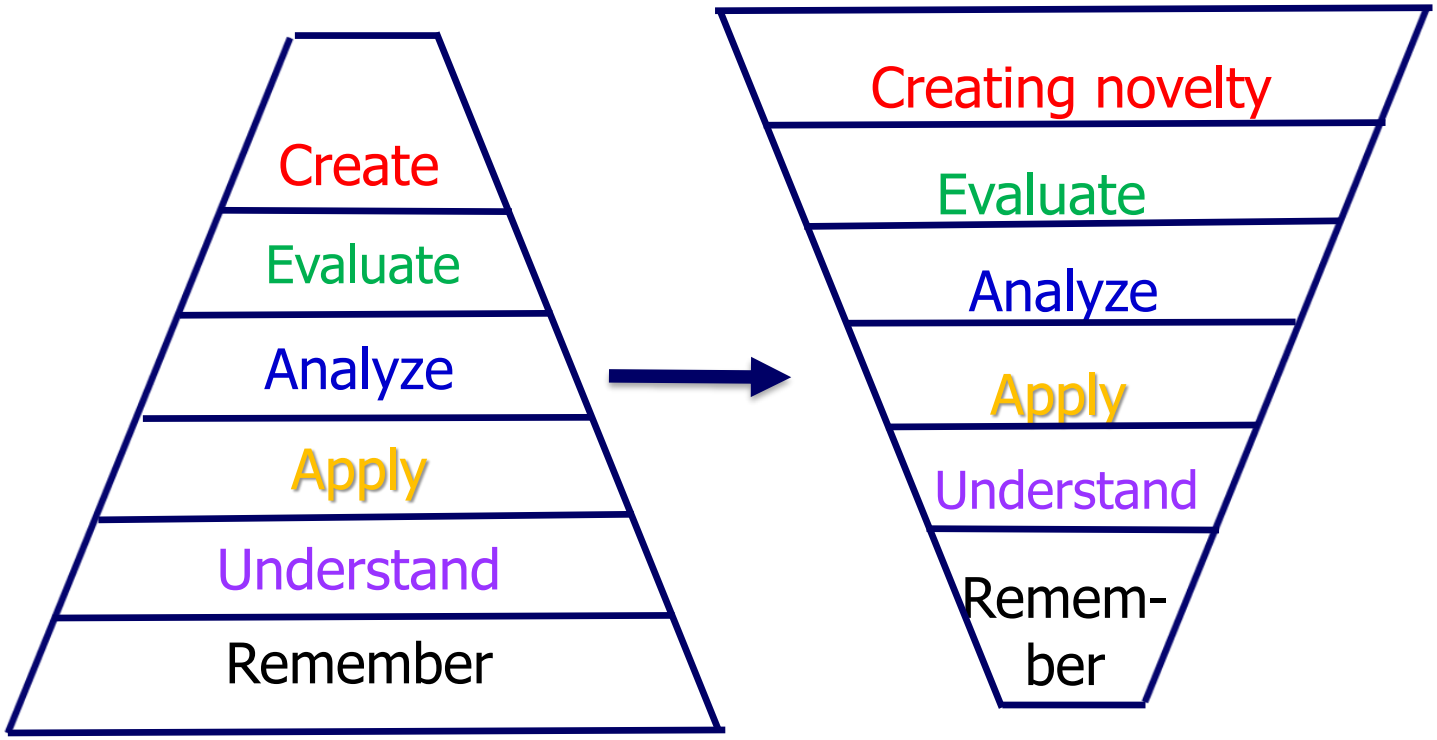
(Organizing processes, pursuing and managing projects)

project work

Eliciting the development of epistemic (trialogical) agency

- Assuming responsibility of advancing collective knowledge
- Agency involved coordinating personal and collective knowledge-creating efforts
- Taking intellectual responsibility of one's own activity rather than relying on authorities.
- **Epistemic agency develops through overcoming difficulties and learning creatively from failures**
- Building on and surpassing prevailing practices, boundaries, and constraints.

Co4-Lab changes epistemic nature of learning (highlighting exploration and discovery, compare Bloom's revised taxonomy)



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Educational innovations require systemic change that involves cultivating new practices of working with knowledge and media (**knowledge practices**)

Progressive Inquiry

- A pedagogical and epistemological model for representing principal features of (scientific) inquiry.
- Students' genuine questions and previous knowledge of the phenomena as a starting point.
- Attention to main concepts and deep principles of the domain.
- Deepening process where the aim is understanding and explanation of phenomena.
- Students and teachers share their expertise and build new knowledge collaboratively.

Belief mode & design mode
(Scardamalia & Bereiter)

- **Belief mode**: Consider ideas and theories as given entities rather than something that can be improved or elaborated. (focus on whether you agree or disagree rather than articulating and and extending ideas
- **Design mode**: Focusing on the usefulness, adequacy, improvability, and developmental potential of ideas and theories.

Knowledge-building approach guides students to treat ideas as improvable artifacts. Toward that end they are engaged in iterative improvement of their ideas as well as digital artifacts embodying them.

Participation gap (Henry Jenkins)

Unequal access to possibilities, competenxies, and knowledge that full participation in the future creative society requires

Disadvantages adolescents

- No access to advanced ICTs beyonf game consoles
- No support in appropriation of advanced ICT competencies
- Narrow and disengaged use of the Internet
- Exclusion from cultures of participation and associated creative activities
- Knowledge and practices dependent on teacher and peer support

Advantaged adolescent

- Rich and multi-faceted ICT resources
- Facilitation for advanced ICT skills
- Use of the internet as a rich and engaging resource
- Deeply in cultures of participation supporting creation of digital media
- Cultural inheritance of creative participation

Gaps between diginatives and educational practices

Digital practices

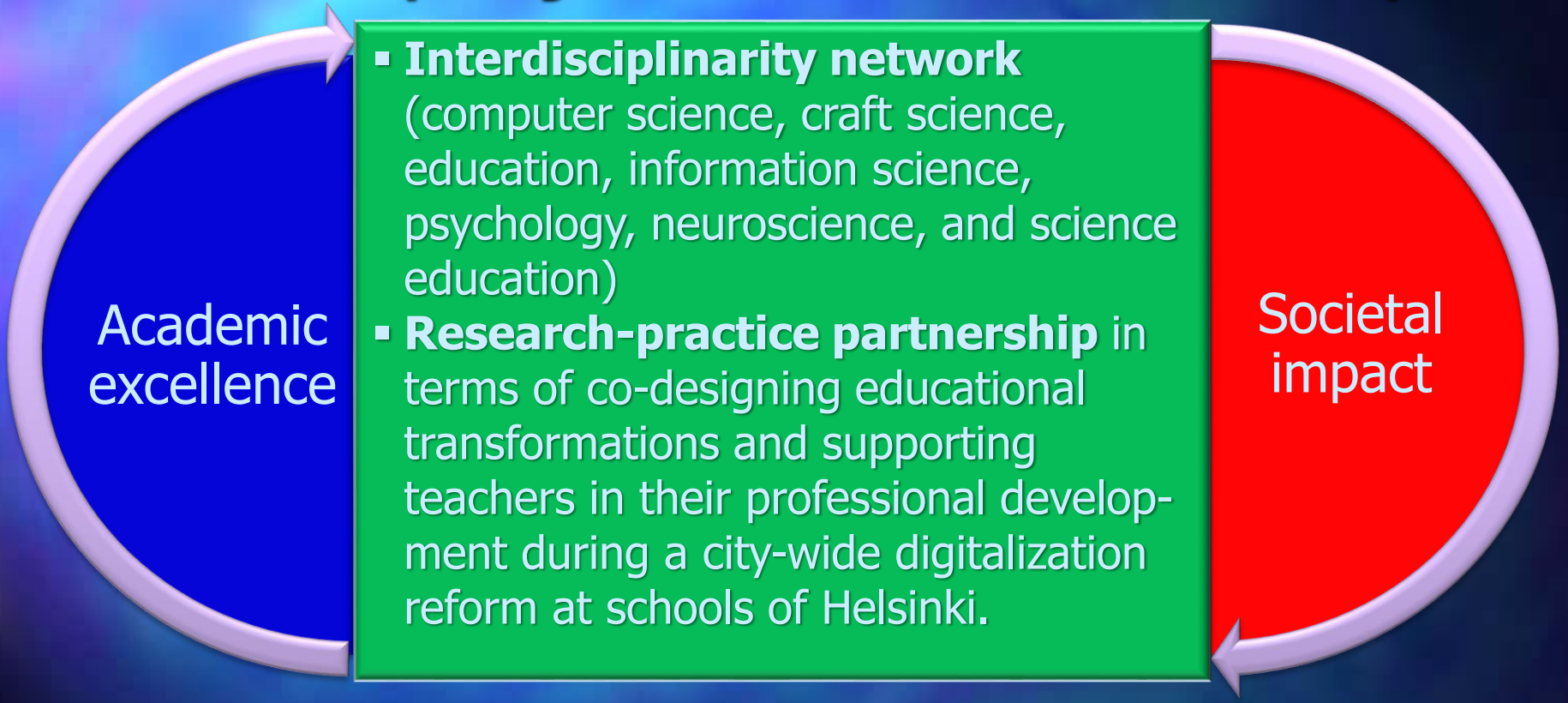
- Working on screen
- Flexible use of tools
- Internet searches
- Ultrasocial activity
- Passionate interest
- Learning by doing
- Extended networks

Educational practices

- Paper and pencil
- Mental performance
- Narrow textbook content
- Individual performance
- External performance
- Learning by telling
- Classroom community

Digital practices of each generation are heterogeneous!

Growing Mind as a strategic research project of the academy



Opening new innovative lines of investigation
Cutting edge theories and methods
High quality articles

Pursuing pedagogic innovations and fostering systemic digital-pedagogic transformations at Helsinki schools

Producing policy-relevant scientific knowledge
Constant interaction with policy makers
Continuous media presence

Four approaches on co-invention

Scientific practice	Engineering practice	Design practice	Entrepreneurial practice
Posing questions	Solving problems	Analyzing design challenges	Finding entrepreneurial possibilities
Generating working hypotheses and theories	Envisioning and constructing solutions	Coming up with design ideas (ideation)	Making entrepreneurial initiatives
Planning and carrying out experiments	Constructing prototypes; exploring and testing iteratively different solutions	Constructing prototypes; Exploring and testing iteratively different design solutions	Carrying out mini experiments to test entrepreneurial initiatives
Analyzing and interpreting data; knowledge seeking	Determining criteria	Analyzing internal and external (customer) constrains	Analyzing customer needs across segments
Visualizing and computationally modelling results	Modelling and simulating technological solutions	Constructing design solutions and representing them conceptually and visually	Carrying out initial market studies and assessing expected social impact
Engaging in arguments from evidence	Comparing and refining solutions and determining optimal ones	Refining design solutions and justifying selection of final one	Determining optimal entrepreneurial approach ja justifying selection
Building and reflecting on knowledge and reporting process of investigation	Building and reflecting on knowledge and reporting product invention process	Building and reflecting on design knowledge and reporting design invention	Building and reflecting on entrepreneurial knowledge and branding and marketing entrepreneurial invention

Epistemic objects (Rheinberger, 1997; Knorr Cetina 1999)

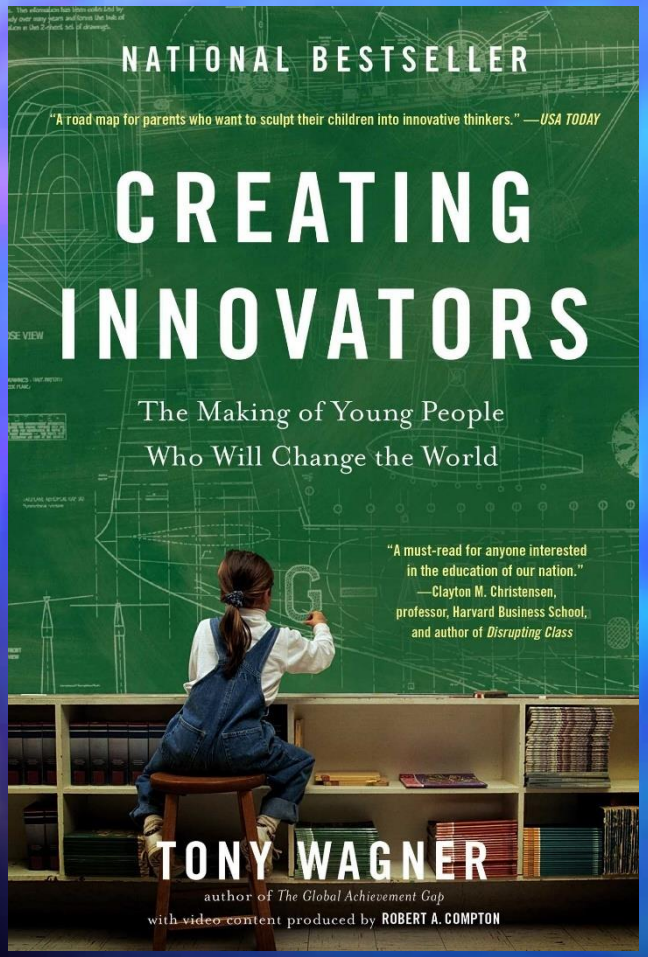
- Epistemic object could be concepts, theories, models and vision
- Epistemic objects are at the edge of knowledge and understanding and represent what is not already known
- Epistemic objects are incomplete, generate constantly new questions and become more complex when pursued:
- *Epistemic objects "appear to have a capacity to unfold indefinitely. They are more like open drawers filled with folders extending indefinitely into the depth of a dark closet. Since epistemic objects are always in the process of being materially defined, they continually acquire new properties and change the ones they have. But this also means that objects of knowledge can never be fully attained, and they are , if you wish, never quite themselves* (Knorr-Cetina, 2001, s. 181).
- Epistemic objects inflame experts' learning and knowledge creation. Pursuing an epistemic object may also inspire knowledge building and making projects.

Knowledge practice: a dynamic social practice for creating novelty and innovation

- **Innovative knowledge community** is deliberately created for cultivating invention and knowledge creation
- It relies on creative, **trans-formative and dynamic knowledge practices** for overcoming unforeseen problems and creative challenges
- Constant effort of **"re-inventing"** knowledge practices [Creative habits, creative routines, creative processes and creative structures]

- *"Far from being the locus of mechanical repetition and mindlessness, practice is instead a key to the comprehension of knowledge-related phenomena. It is in practice, in fact, that knowledge comes to life, stays alive, and fades away. It is in practice that institutionalized, historically determined, and codified expertise acquires sense and becomes both a resource and a constraint for action" (Nicolini, Gherardi, & Yanow, 2004, p. 26).*

Educating inventors

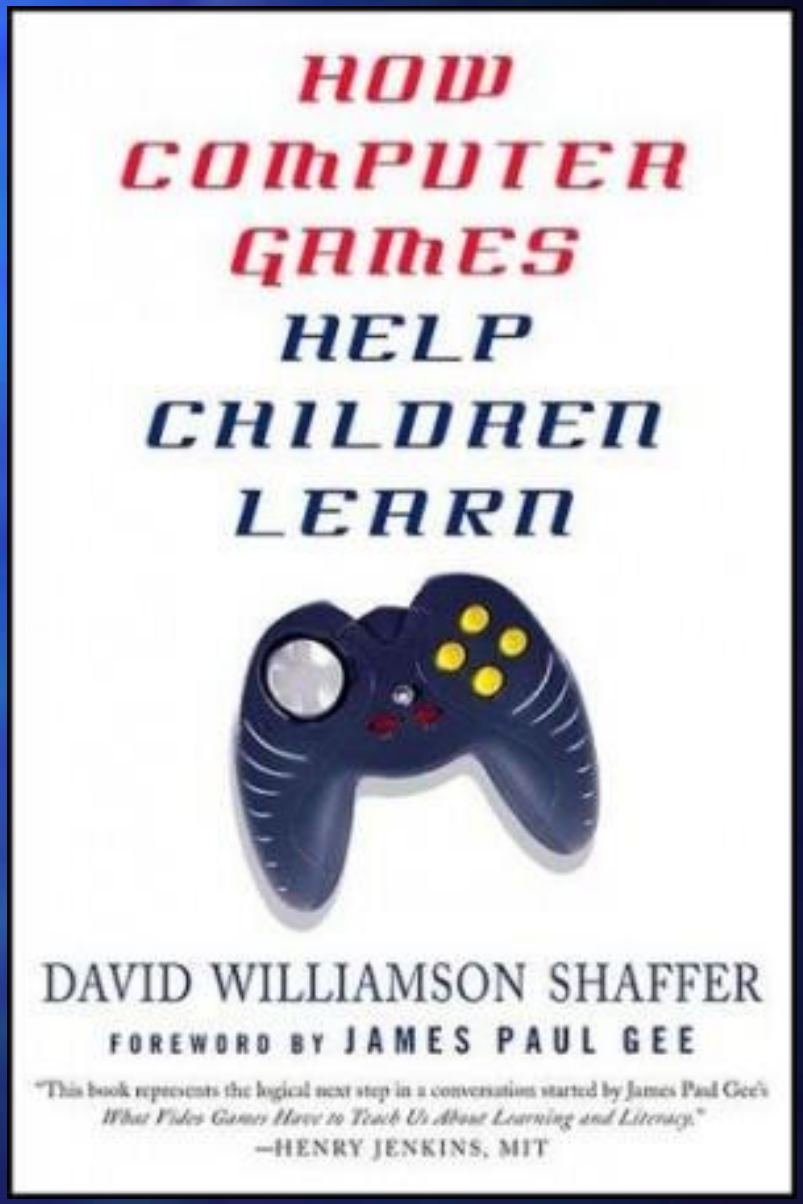


- Operational methods of creative making that provide access to experts methods, practices and networks
- **Creating spaces (fablabs) for making and inventing artifacts at school**

- Everybody can be an inventor
- Best ideas are co-created
- Ideas develop by exploration
- Inventing requires sustained effort across iterations
- Experts support the process

Epistemic games

Epistemic game refer to a structured gaming activity for deliberately creating an epistemic frame related to socially valued activity for re-creating processes that enable participants for developing skills, knowledge, identity, values, and epistemology related to the activity



Defining epistemic games
(Shaffer; Markauskaite & Goodyear)

- Enhancing and transforming knowledge practices may be understood in terms of appropriating the principal features of epistemic games characterizing expert communities
- Epistemic games are identifiable but partially hidden patterns and structures that professional and academic epistemic cultures have cultivated across their history and successfully employ for enculturating new generations of creative knowledge workers.
- Epistemic games represent generative systems of creative habits, patterns, routines, practices that mediate inventive activity, corresponding to flexible cultural scripting or programming of open-ended creative activities.
- Talking about 'games' is justifiable because disciplinary inquiries involve identifiable goals, moves and rules, and sometimes also competition. In the present context, epistemic games are hybrid social-digital activities rather than actual digital gaming, providing a useful metaphor for conceptualizing creative practices of using socio-digital technologies.
- Epistemic fluency can be understood as a capability of recognizing and practicing many different epistemic games for solving complex problems, carrying out deepening inquiries that cross domains, going beyond the information given, integrating informal and academic knowledge, and inventing something new.
- The prevailing education practices rely on fairly rigid epistemic games, mostly reproductive (non-creative) in nature, which do not prepare students for productive functioning in the innovation society.
- Radical educational changes are needed for socializing young people, early on, to epistemic games involved in the pursuit of novelty and invention.

Modelling epistemic games

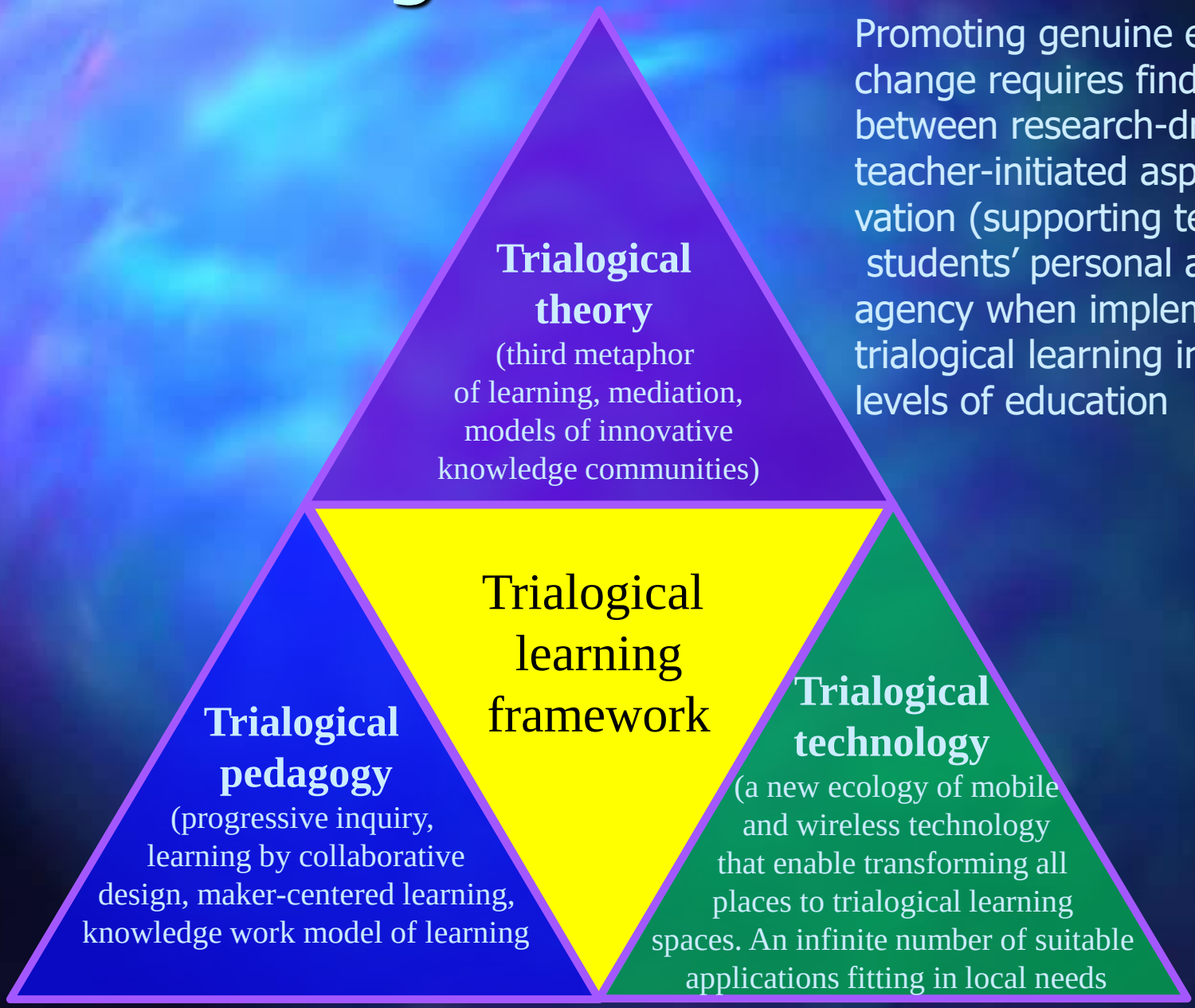
- Traditional school learning may be understood as a specific type of epistemic game that determine roles (student, teacher), tasks, knowledge resources (textbook), production of correct answers, summative assessment, and expected behaviours (hidden curriculum).
- Our pedagogic transformation efforts, in contrast, aim at initiating and cultivating more innovative and "thick" epistemic games and changing students and teachers views regarding what is possible
- Toward that end, it is investigated practicums through which expert cultures guide newcomers to appropriate complex formal and informal competences, augmenting education with expert reality
- Newcomers practice epistemic activity through exploration, feedback, and reflection at the zone of proximal development (thinking and acting in a role of an expert)
- Internalization: iterative effort at the upper edge of competence in cycles of failing and reflecting for solving complex problems and appropriating experts tacit knowledge, professional vision, value, identity, epistemology
- Epistemic games deliberately imitate and model activity and reflection that produces expert knowledge, skills, and epistemology

Journalism practicum (Shaffer 2006)

- Students functioned in teams across a semester for writing an investigative article to a local newspaper in interaction with experienced journalists
- Expert practices that newcomers may appropriate
  - **War stories:** describe learning events regarding one's own career (what a journalist has to know, do and care about as a "watch dog")
  - **News meetings**, where journalists present their story ideas to a critical workplace community (how to frame stories, bringing a personal story about)
  - **Copy-editing**, where a group of journalists comment on each other's stories
- Build a story from pieces: make influence rather than master mere routines
- Tell the deeper story behind stories (epistemology for justifying arguments)
- Research: concept map; reflection what it means to be a journalist; reflection what to do after getting a hint of story (operational understanding)

Trialogical framework

Promoting genuine educational change requires finding balance between research-driven and teacher-initiated aspects of innovation (supporting teachers' and students' personal and collective agency when implementing trialogical learning in different levels of education

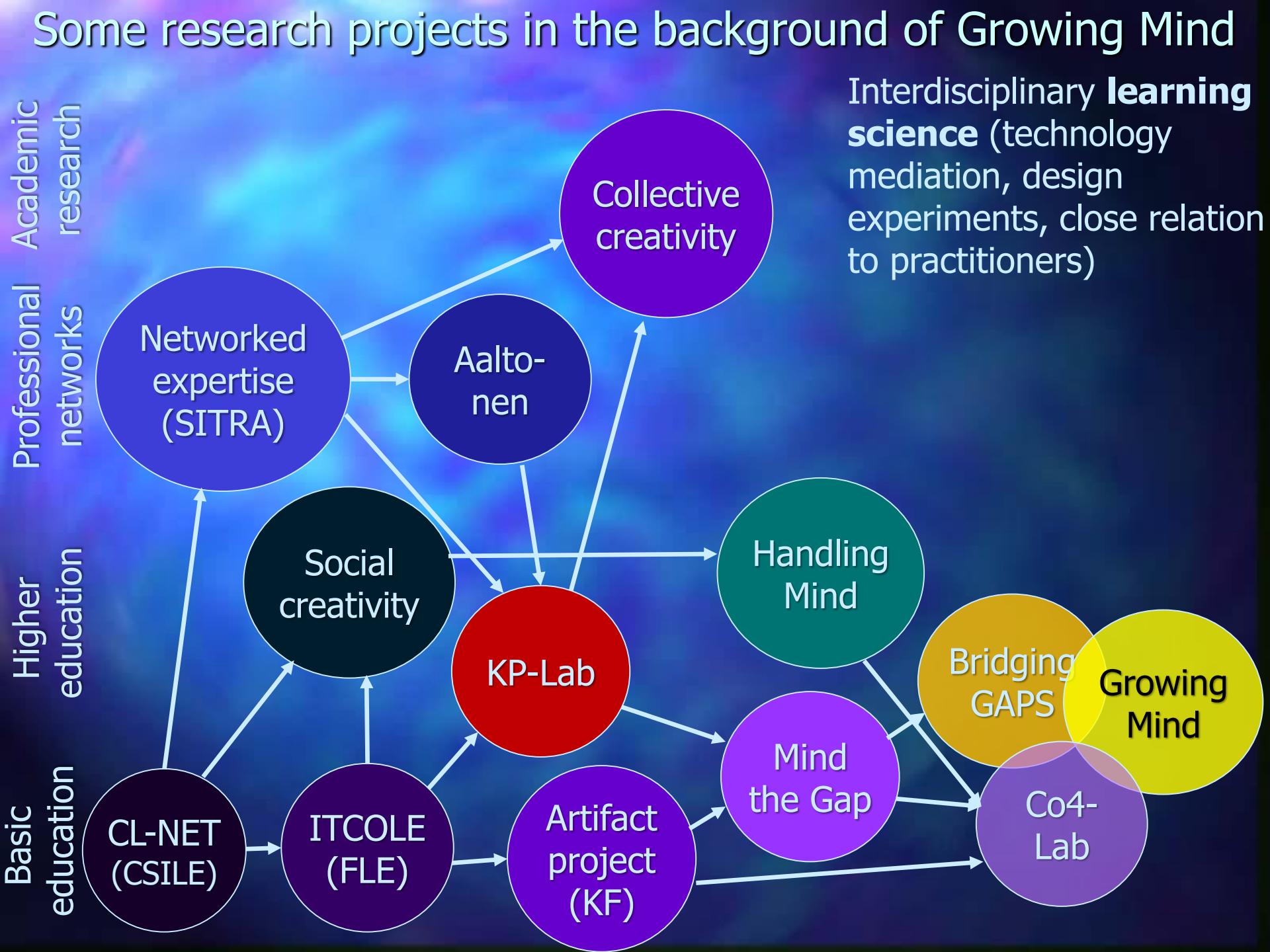


Network of research projects regarding technology-mediated learning

- Future Learning Environments (FLE, 1999-2000, 2000-2001)
- European Collaborative Learning Networks (CL-NET, 1998-1999)
- Innovative Technology for Collaborative Learning (ITCOLE, 2000-2002)
- Integrated Knowledge Practices Laboratory (KP-Lab, 2005-2009)
- Mind the Gap between digital natives and educational practices (2011-2015)
- Laboratory of Co-design, Co-inquiry, Co-teaching and Co-regulation (Co4-Lab, 2015-2019)
- Growing Mind: Personal, social, and institutional renewal at the digital age (Strategic Research, 2018-2023)

- Digital technologies and associated practices function as **agents of educational change**
- Research and development of technology-mediated learning environments by **multi-disciplinary collaboration**
- **Design experiments** that involve iterative efforts of experimenting with innovative ways of learning and teaching at the field

Some research projects in the background of Growing Mind



Generation 1: Inquiry learning

- Examining learning as knowledge-seeking inquiry (progressive-inquiry (PI) pedagogy)
- Showing that even elementary-school students are able to engage in a very advanced inquiry driven by their own questions and explanations
- Students follow the pattern of interrogative inquiry and engage in productive discourse interaction
- Focus: how technology-enhanced learning elicits conceptual advancement and change.

Cognitive reductionism: Puzzling invisibility of social practices

- **Dilemma**: Progressive inquiry culture could not be transferred from Canada to Finnish elementary schools dominated by pursuit of fact-seeking questions and fragmented knowledge
- *What were the invisible foundations of knowledge-building inquiry that we were not able to convey to the teachers in question (explaining both success and failure)?*
- Foregrounding students' knowledge structures and their processes of conceptual change made most of the interesting and relevant socio-cultural phenomena disappear from the focus of inquiry.

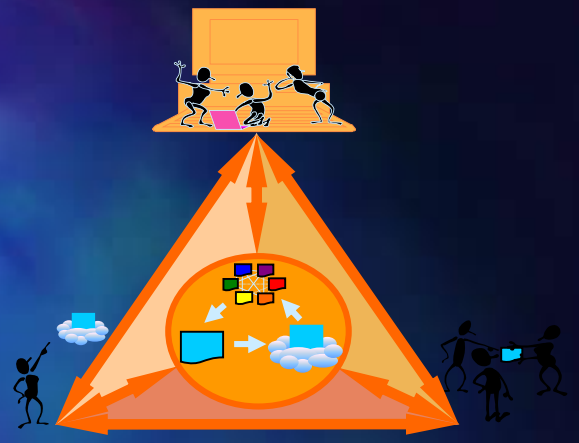
Generation 2: Social participation

- Analyzing (formerly invisible) classroom practices needed to make progressive inquiry to work
- Starting to videotape processes of teacher guidance (inquiry cultures capitalize on teachers' unaccounted invisible work)
- Analyzing patterns of participation in computer-supported learning by relying on social network analysis (from individual to relational phenomena)
- Expanding the scope of investigations toward workplace communities (climbing out of the box)

Situational reductionism: Puzzling invisibility of epistemic mediation

- **Dilemma**: While addressing social networks and practices we tended to loose sight of genuine knowledge advancement
- When here-and-now group interactions are foregrounded (Stahl, 2006; Wegerif, 2007), it appears to make invisible concrete epistemic activities – needed for deepening inquiry – that students engage in while producing knowledge to technology-mediated learning environments' databases.
- It does not make sense to replace cognitive reductionism with situated one.

Generation 3: Trialogical framework



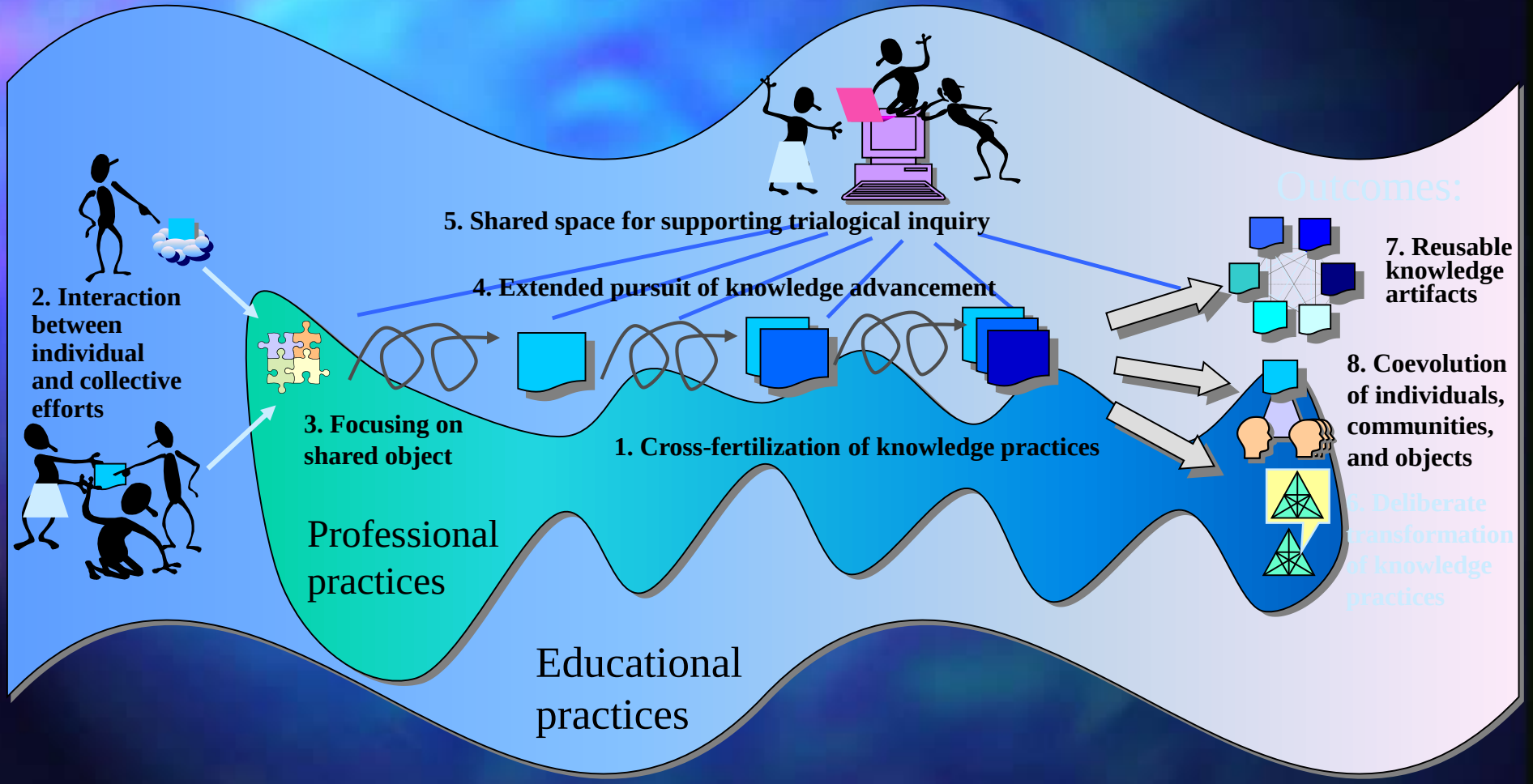
- **The third metaphor:** overcoming the dichotomy between the acquisition and participation perspectives.
- The trialogical approach foregrounds the **objective** aspect of learning allowing simultaneously to acknowledge both the **subjective** and **intersubjective** ones.
- Evolving framework for examining knowledge-creation processes in **educational** and **professional** contexts (including academic research).

Progressive Inquiry Model (Investigative learning, Hakkarainen, 1998)

Learning by Collaborative Designing (LCD) model

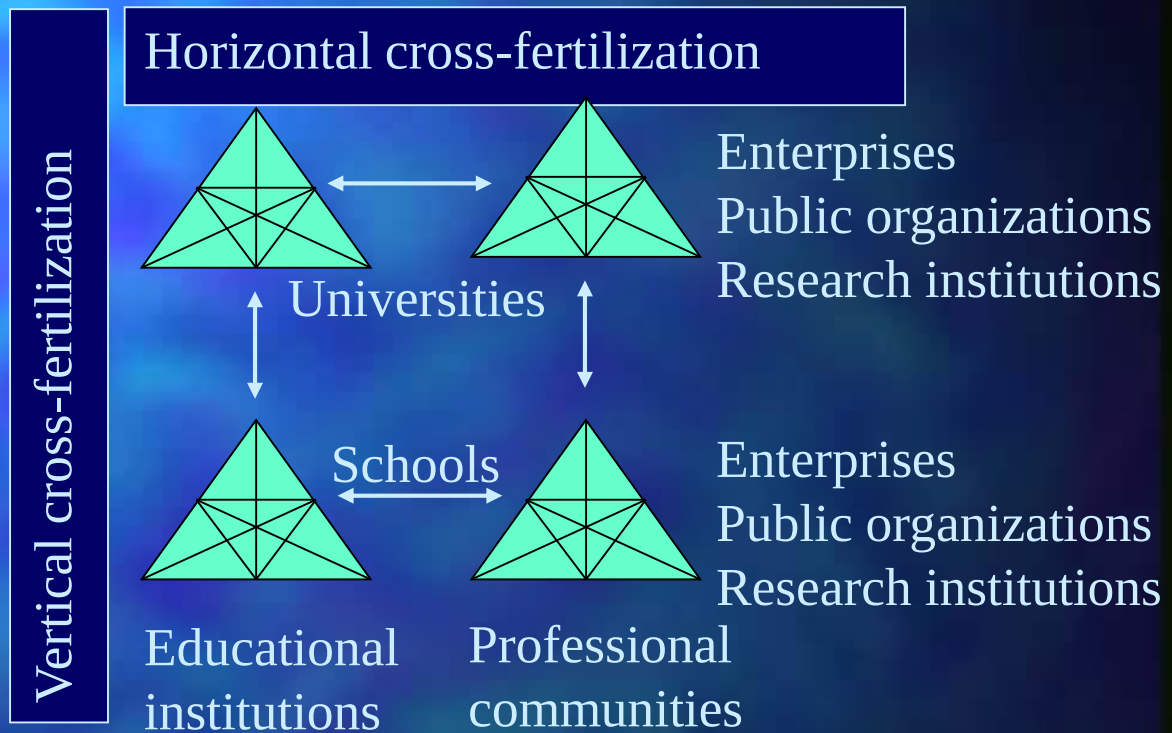
(Seitamaa-Hakkarainen, 2001)

The process of trialogical inquiry in Distributed Work Case

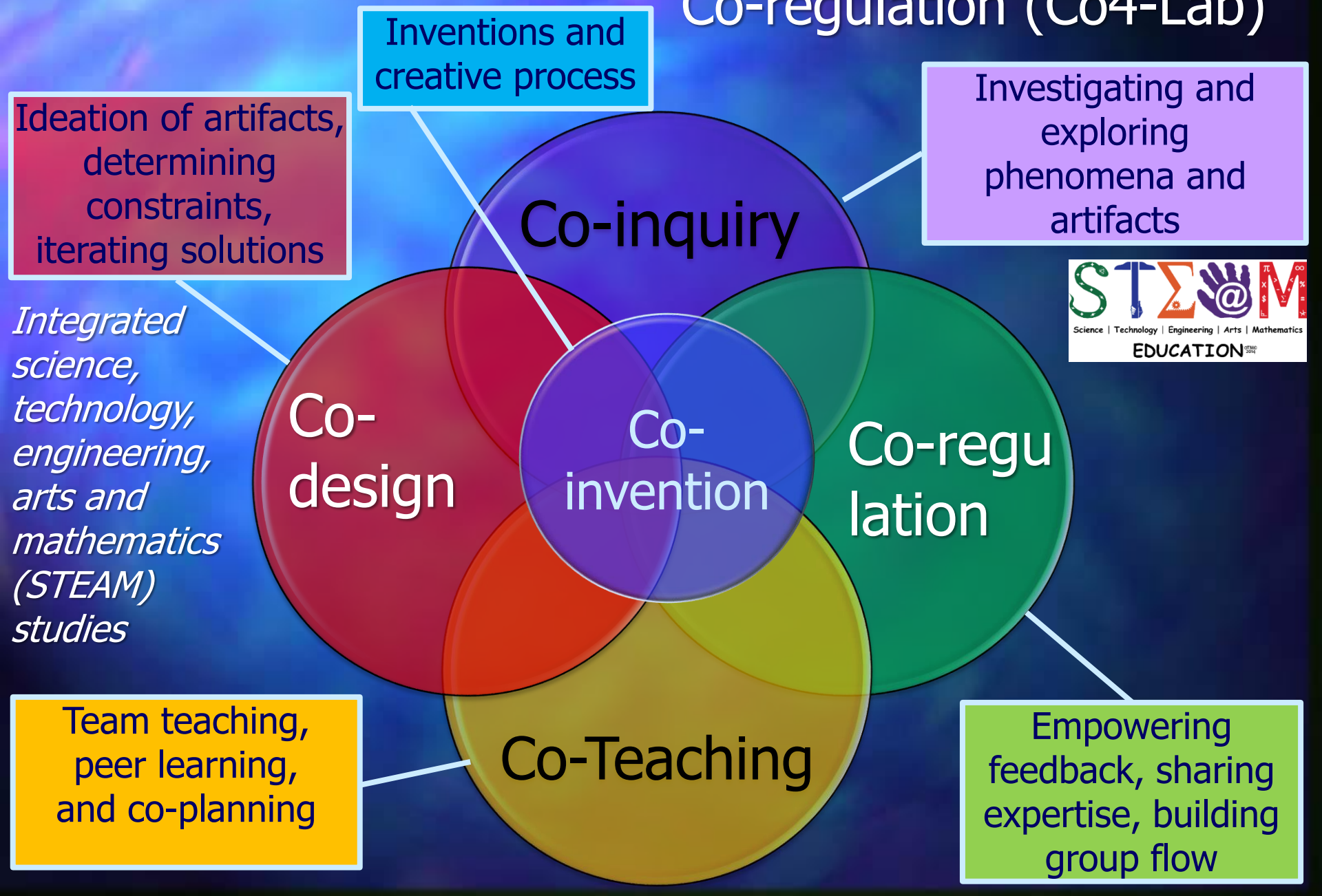


Horizontal and vertical boundary crossing

- Organizing boundary-breaking courses focused on analyzing complex problems
- Team-based organization for pursuing knowledge intensive work
- Engaging students in fieldwork



Laboratory of Co-Design, Co-Inquiry, Co-teaching and Co-regulation (Co4-Lab)

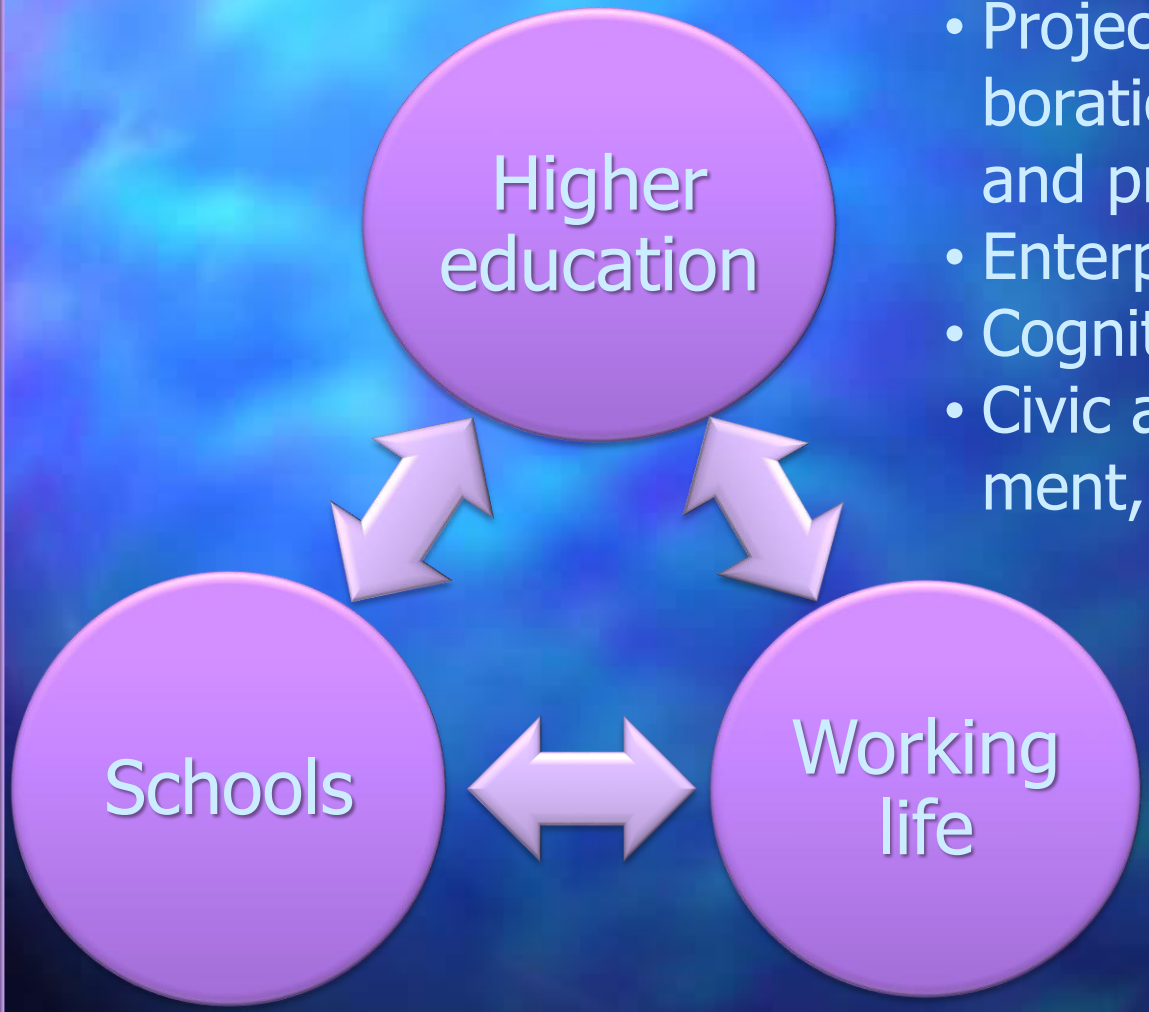


Social capital (Rheingold, 2012)

- A capacity of individual and communities to get things done outside of formal institutions

Connecting	• Creating network relations based on mutual trust (sharing contexts; investing in collaboration)
Reciprocity	• Proactive orientation to support others so as to build reciprocity (horizontal, non-authoritative relations)
Bridging	• Creating diverse and far-reaching network relations so as to bridge strucrtural holes (the strength of weak ties)
Bonding	• Creating ties and collections between participants functioning in diverse communities and network so as to elicit collaboration

Horizontal and vertical cross-fertilization of knowledge practices



- Projects that involve collaboration with enterprises and professional organization
- Enterpreneurship education
- Cognitive apprenticeship
- Civic activity (local environment, global disasters)

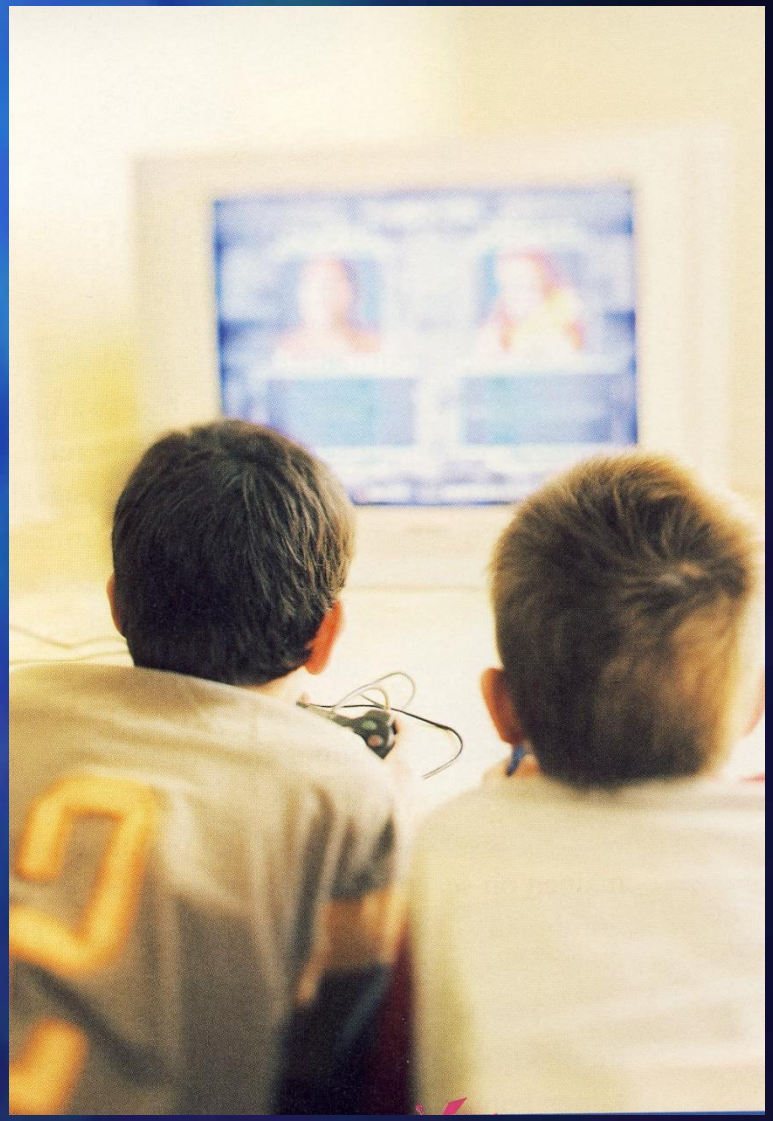
World is changing so rapidly that parents' generation cannot provide similar support to young people than they themselves got

Vertical cross-fertilization

Horizontal cross-fertilization

Three generations of research on technology-mediated learning

- The present approach emerged from efforts of **overcoming challenges and tensions** encountered in our research and development efforts
- The three generations correspond the three metaphors of learning
- Generations are associated with theoretical and methodological transitions

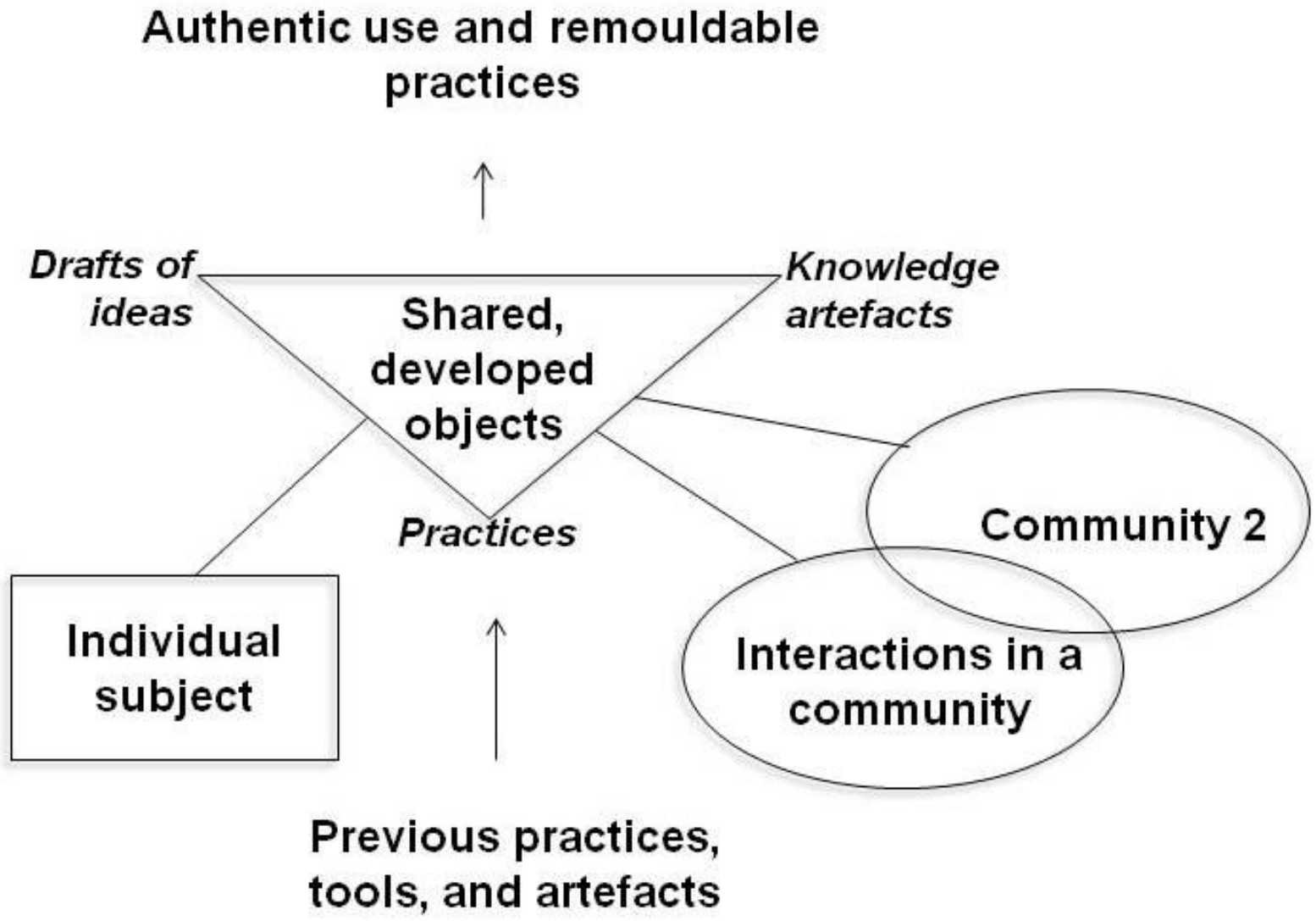


Toward trialogical knowledge practices

Kosonen, & Lakkala)

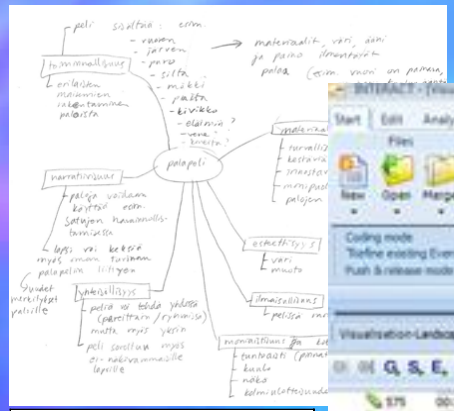
Epistemic artifacts	• Shallow discussion vs crystallizing ideas to artifacts
Epistemic objects	• Closed ideas vs complex, open problems
Shared expertise	• Individual working vs joint versioning and commenting
Iterative investigation	• One-shot effort vs iterative, sustained pursuit
Epistemic agency	• Personal vs collective cognitive responsibility
Cross-fertilization	• Domain-specific vs cross-fertilizing knowledge practices
Expansive learning	• Conceptual inquiry vs expansive transformation of practices

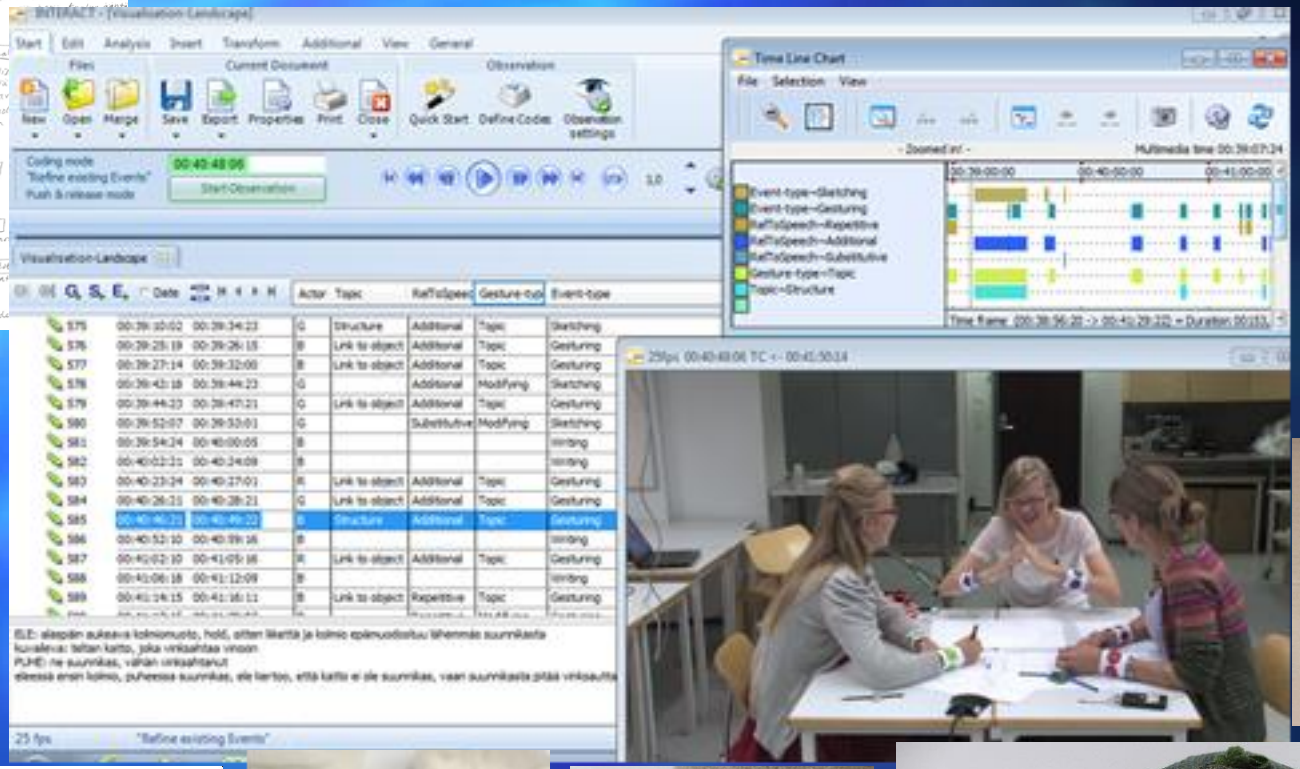
Technology mediated elements of the trialogical approach on learning (Paavola, Engeström, & Hakkarainen, In press)

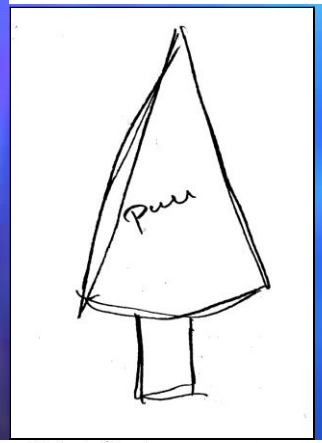


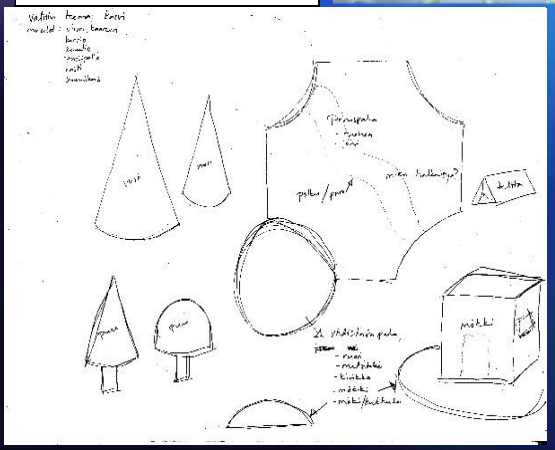
	Nonaka & Takeuchi	Engeström	Bereiter
The role of individual expertise	Individual are taken as given, individuals create knowledge	Social theory of mind, individuals embedded in socio-cultural contexts	Theory of expertise
Main focus	Tacit knowledge (insighting)	Knowledge embedded in practices (acting)	Knowledge objects (conceptualizing)
Type of processes focused	Emphasize bodily processes, personal experience	Emphasize material object-oriented activities	Emphasize solving of knowledge problems
Source of innovation	Transforming tacit knowledge to explicit knowledge	Overcoming tensions, disturbances, and ambiguities by expansive learning	Working deliberately to extend and create new knowledge objects
Scope of framework	Different ontological levels from individuals, groups to organizations	Activity systems and networks of activity systems	Knowledge-building communities

Co-designing 3D puzzles for visually impaired children (Handling Mind)

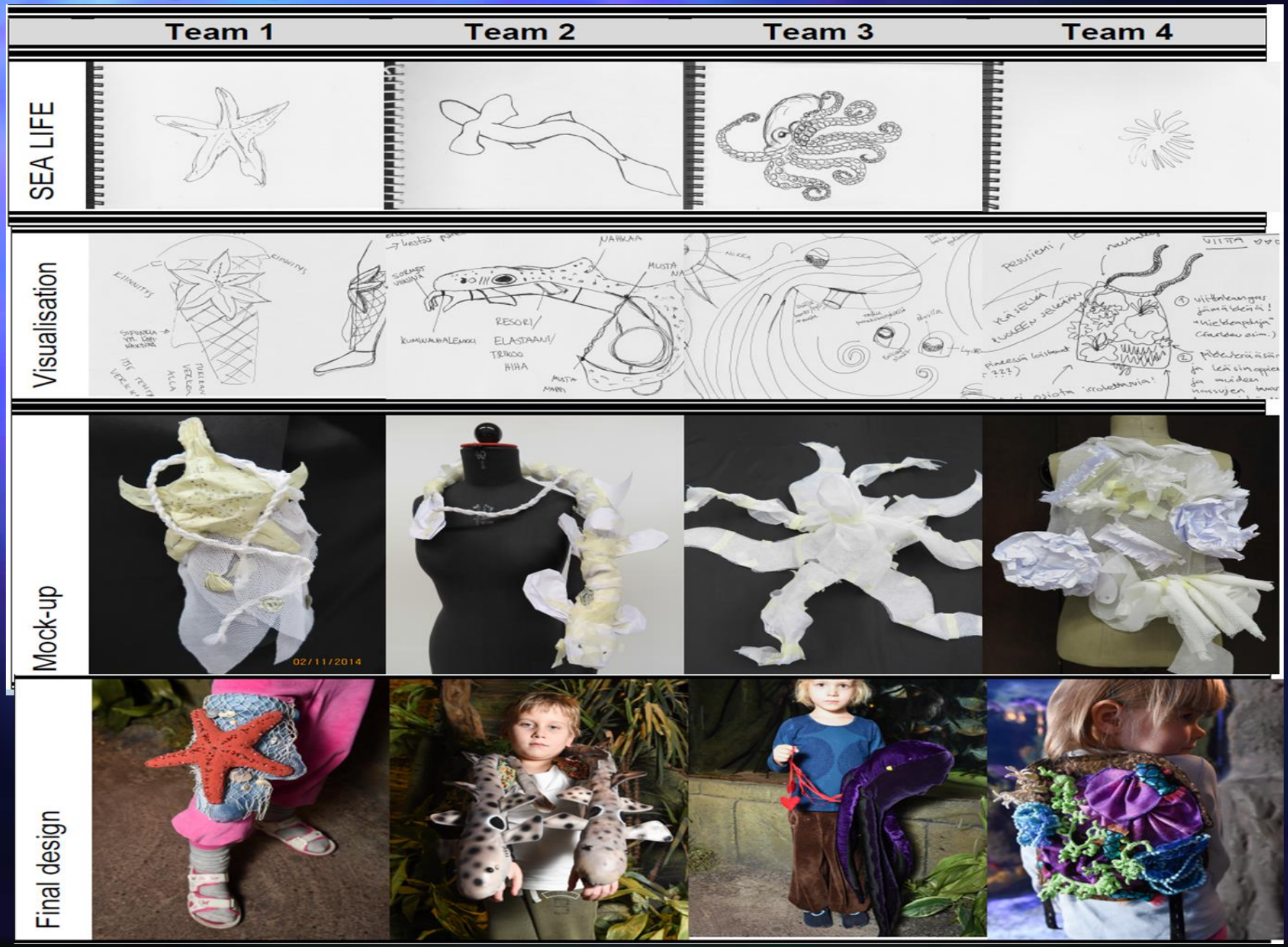






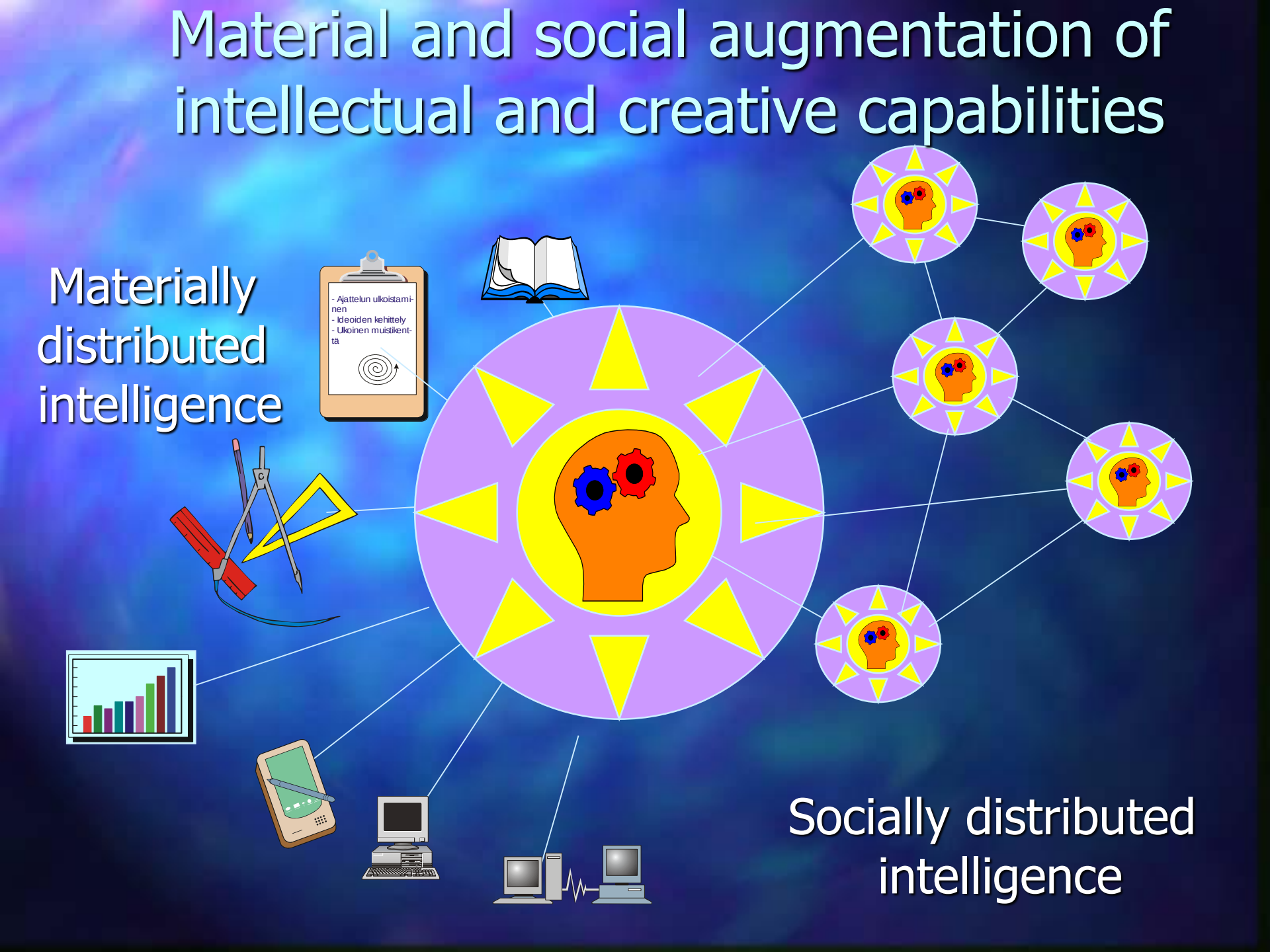


Co-designing wearable sea creatures for 3-6 year old kids



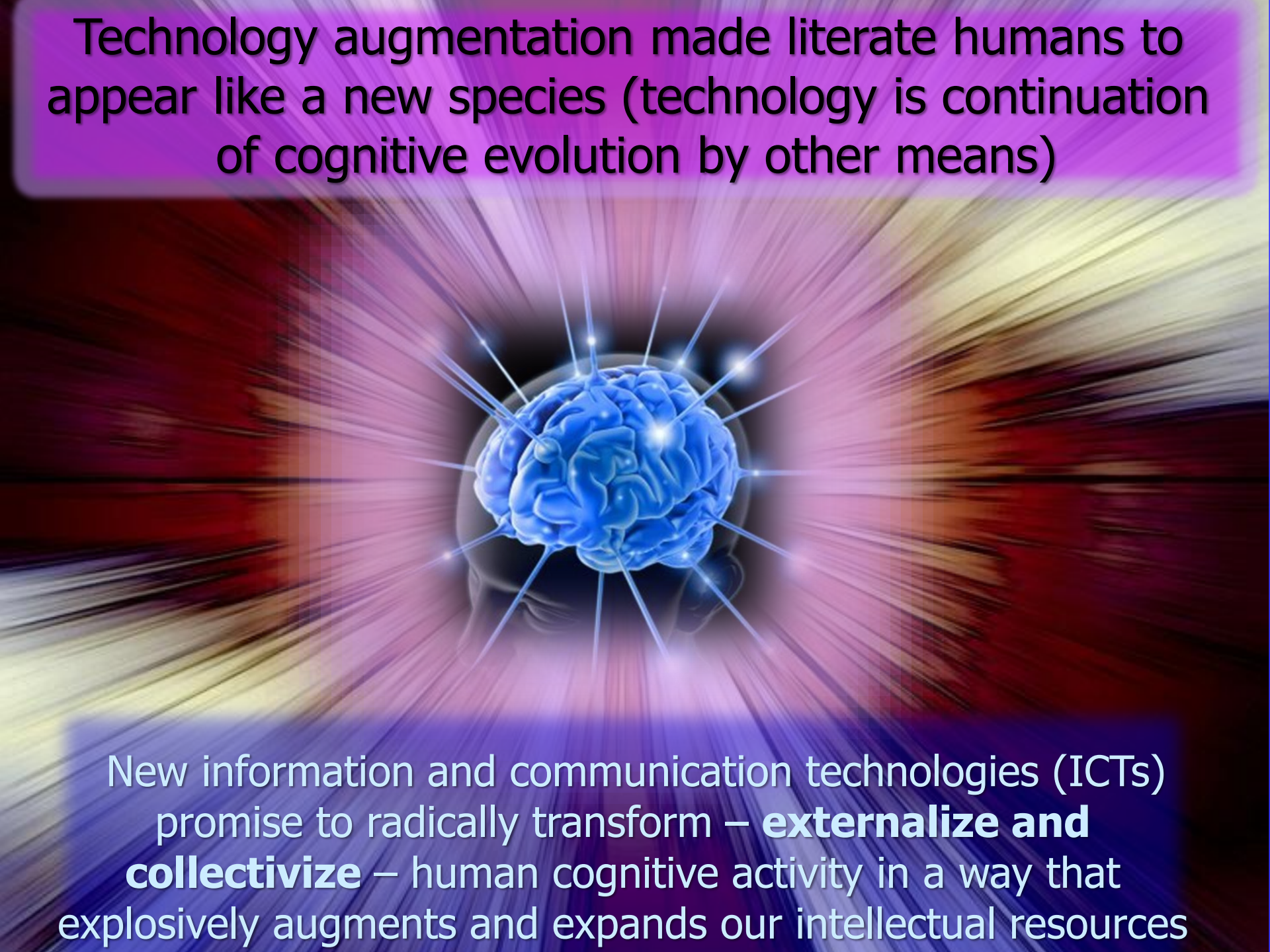
Material and social augmentation of intellectual and creative capabilities

Materially distributed intelligence



Socially distributed intelligence

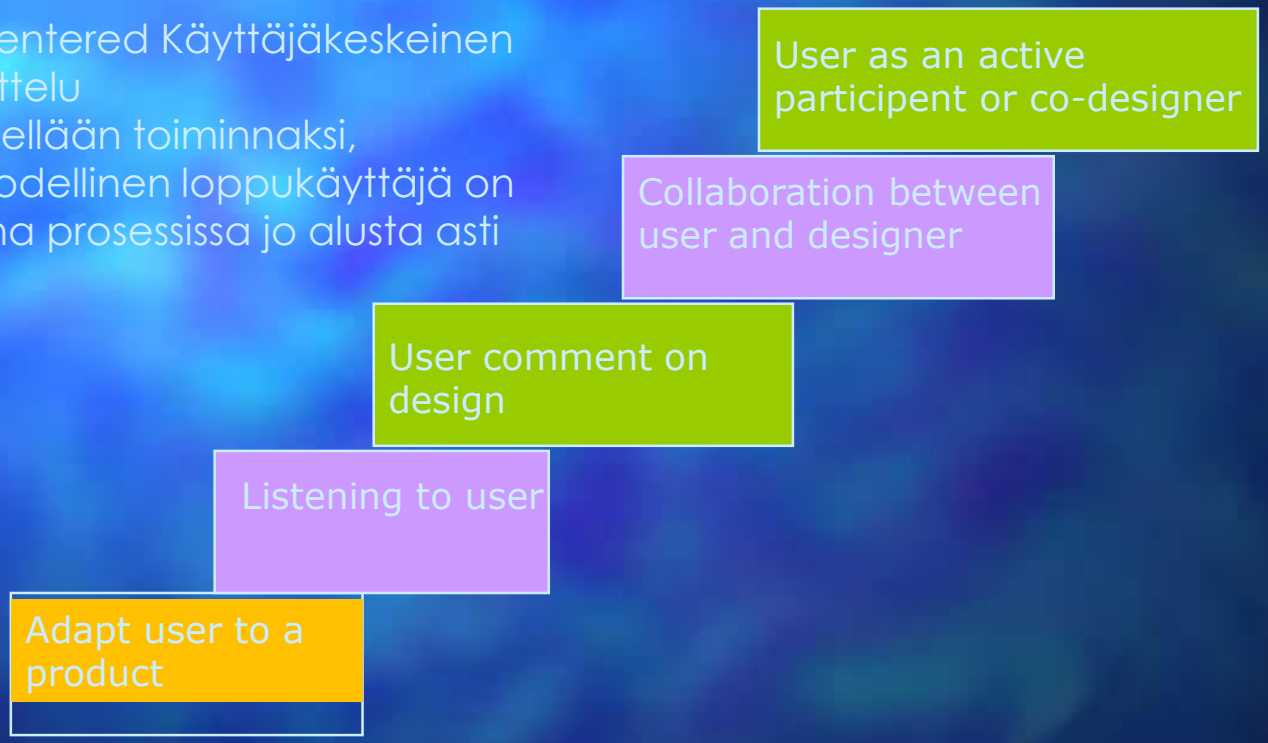
Technology augmentation made literate humans to appear like a new species (technology is continuation of cognitive evolution by other means)



New information and communication technologies (ICTs) promise to radically transform – **externalize and collectivize** – human cognitive activity in a way that explosively augments and expands our intellectual resources

User-centered design: level of user involvement in design process

User-centered Käyttäjäkeskeinen suunnittelu
määritellään toiminnaksi,
jossa todellinen loppukäyttäjä on mukana prosessissa jo alusta asti



Challenges of integrating digital technologies with educational practices

- After 20 years of efforts, digital technologies did not root as a part of Finnish schools.
- Digitalization of **the matriculation examination** has changed the situation considerably
- **Emerging socio-digital ecology** (Mobile and wireless technologies, thousands of adaptable applications, new generation of teachers, and new institutional commitment
- Schools tend to reduce new (**disruptive**) innovations to ones **sustaining** their prevailing practices (research-practice partnership)

School improvement requires **research-practice partnership** aimed at cultivating new practices of working with knowledge and media (**knowledge practices**)