

2016/17 KNOWLEDGE SHARING PROGRAM WITH Costa Rica

Korea Development Institute

Final Reporting Workshop

**STEAM Education for S&T HRD and
Policy Suggestions for Costa Rica**

January 22nd 2017

Contents

1. Introduction

2. Analysis on the current status in Costa Rica

3. Korean Experiences and Implication

4. Policy Suggestions

1. Introduction

A. Key Points from mutual understanding

S&T HRD is an important key factor for competitiveness enhancement in knowledge based economy

In a long-term perspective, supplying high quality S&T HR will greatly contribute to the transition to the innovation driven economy, and STEM education plays a vital role in establishing stable HR supply system

For this, this project aims to suggest short and mid-long term policy strategies which can be helpful for STEM education development in Costa Rica

1. Introduction

B. Tentative Table of Contents

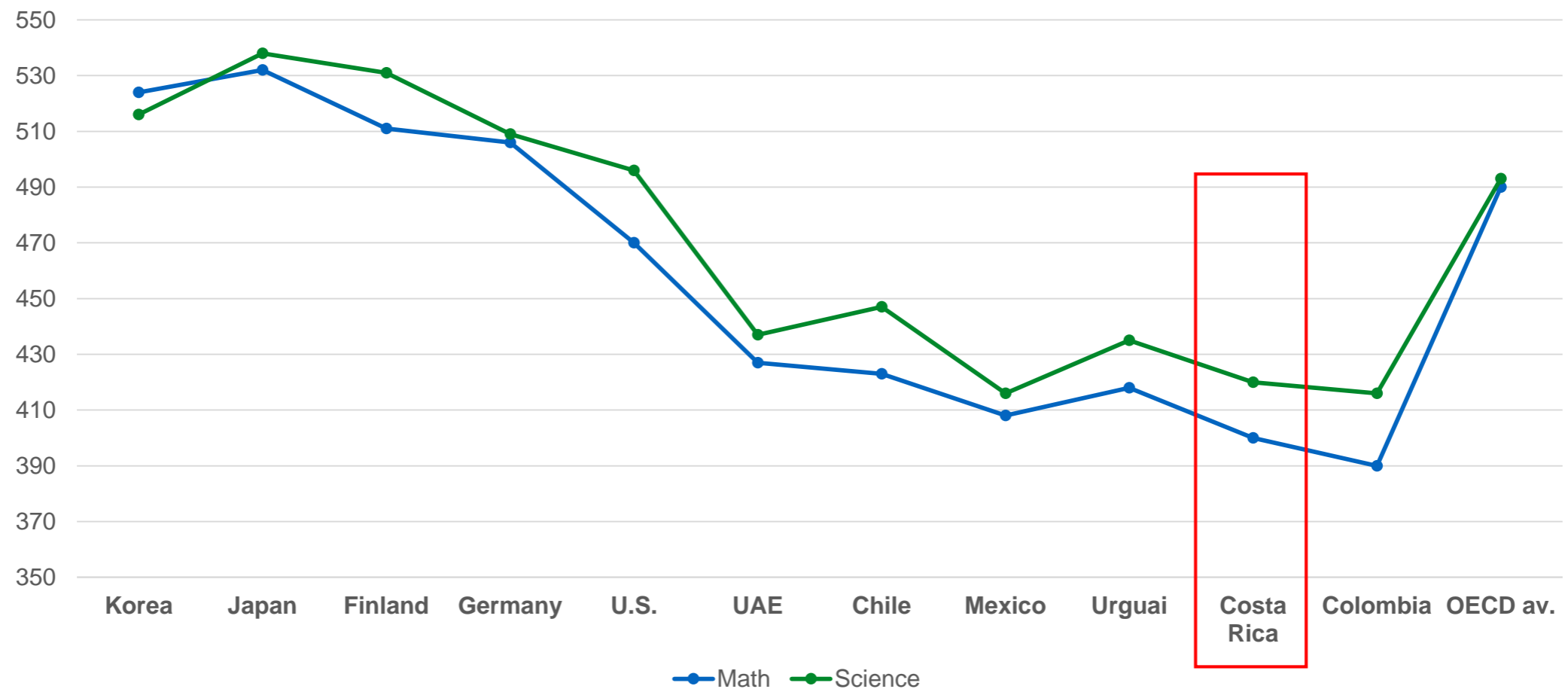
- Introduction – research motivation
- STEM education in Costa Rica
- STEAM education : Korean experience
- Policy suggestions

C. Research Methodologies

- Literature/documents analysis
- In-depth semi-structured interviews
- Survey on regional science advisors (7/28)

2. Analysis on the current status in Costa Rica

A. International comparison : OECD PISA

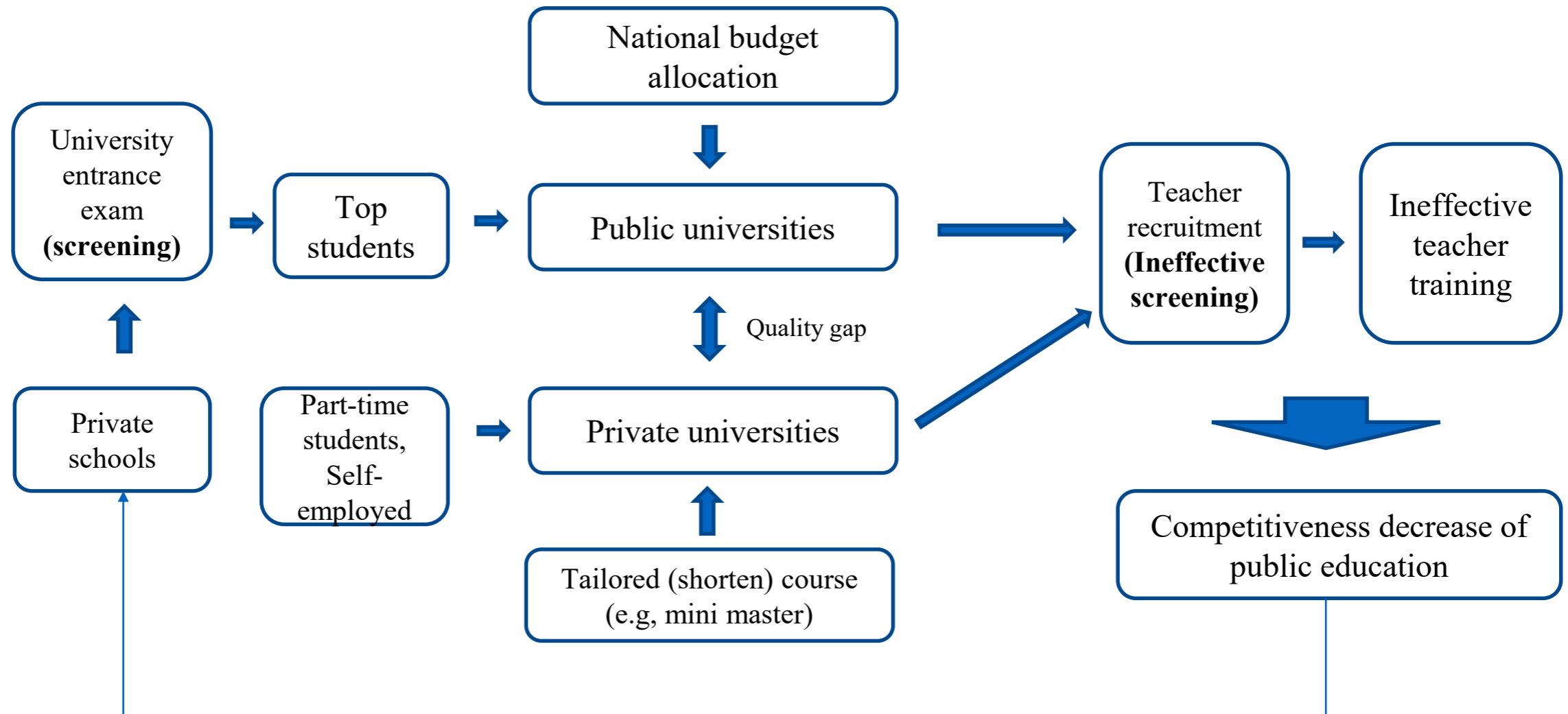


- **Costa Rica is a country with one of the smallest gap between top and bottom 10%**
- **The proportion of top-performers in science and math is one of the lowest (62/69 and 65/69)**

2. Analysis on the current status in Costa Rica

B. Obstacles and Challenges

(1) Teacher Quality Issue: vicious cycle



2. Analysis on the current status in Costa Rica

B. Obstacles and Challenges

- (2) Science, Technology, Engineering and Math are not correlated as one yet in the educational system. They are taught generally as individual subjects**
- (3) There is no special track for talented students. Scientific high schools are not successful in keeping these top students in science and technology field**
- (4) Because of industry structure and focus on teaching in university, the demand of high level S&T HR from higher education and industry is not substantial**
- (5) According to PISA, imbalance between boy and girl STEM performance is already serious, and this can cause a future gender issue in STEM related jobs.**

3. Korean Experiences and Implication

A. Backgrounds

- Large demands from industry with economic development with drastic economic development (12% annual growth)
→ Established KAIST and Special Science high school to meet this S&T HR needs
- However, IMF crisis & dot.com bubble caused the phenomenon of avoiding science and engineering, and intensive S&T learning (despite high performance) decreased students self-motivation
- Thus, to enhance self-motivation and creative thinking by providing multidisciplinary education, STEAM was introduced in 2011 by MEST

3. Korean Experiences and Implication

B. STEAM education policy : 5 main policy goals

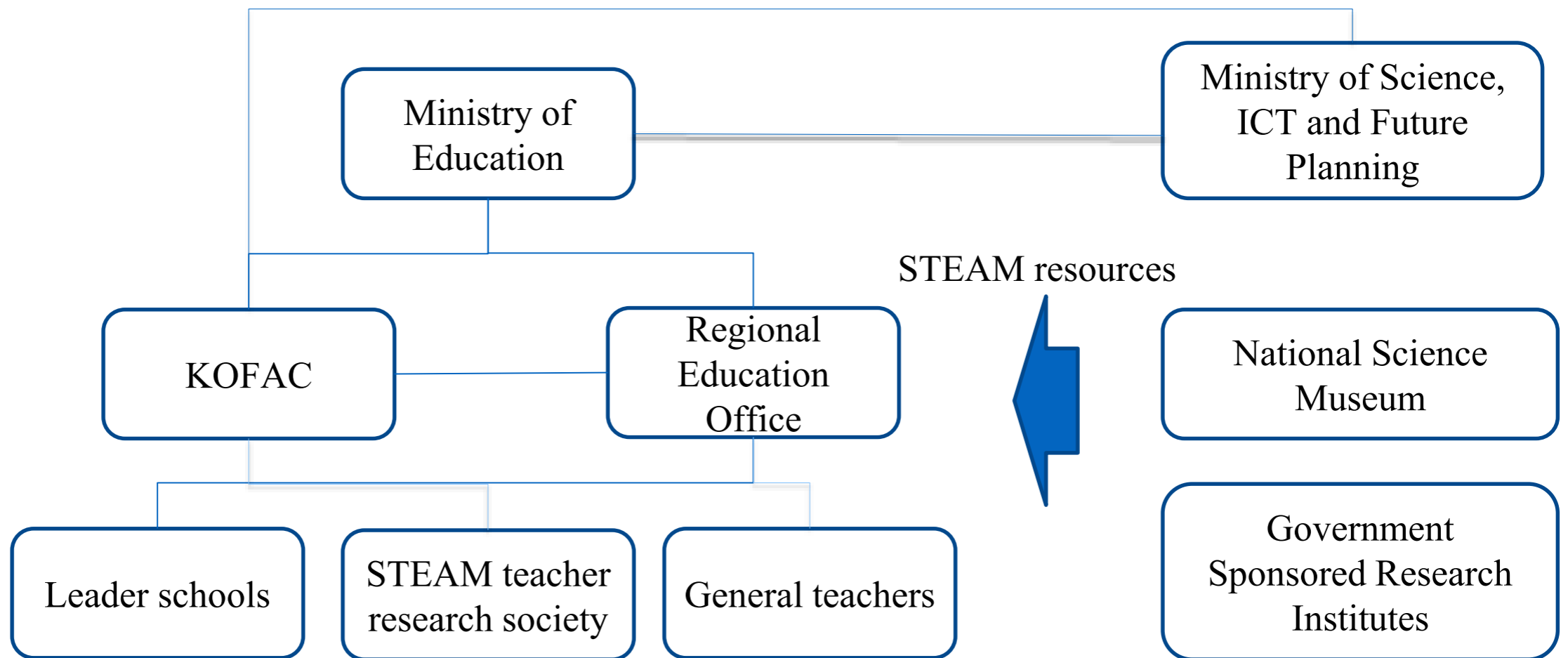
“Nurture Creative Human Resources in Science and technology”



Source: KOFAC (2015)

3. Korean Experiences and Implication

B. STEAM education policy : Implementation structure

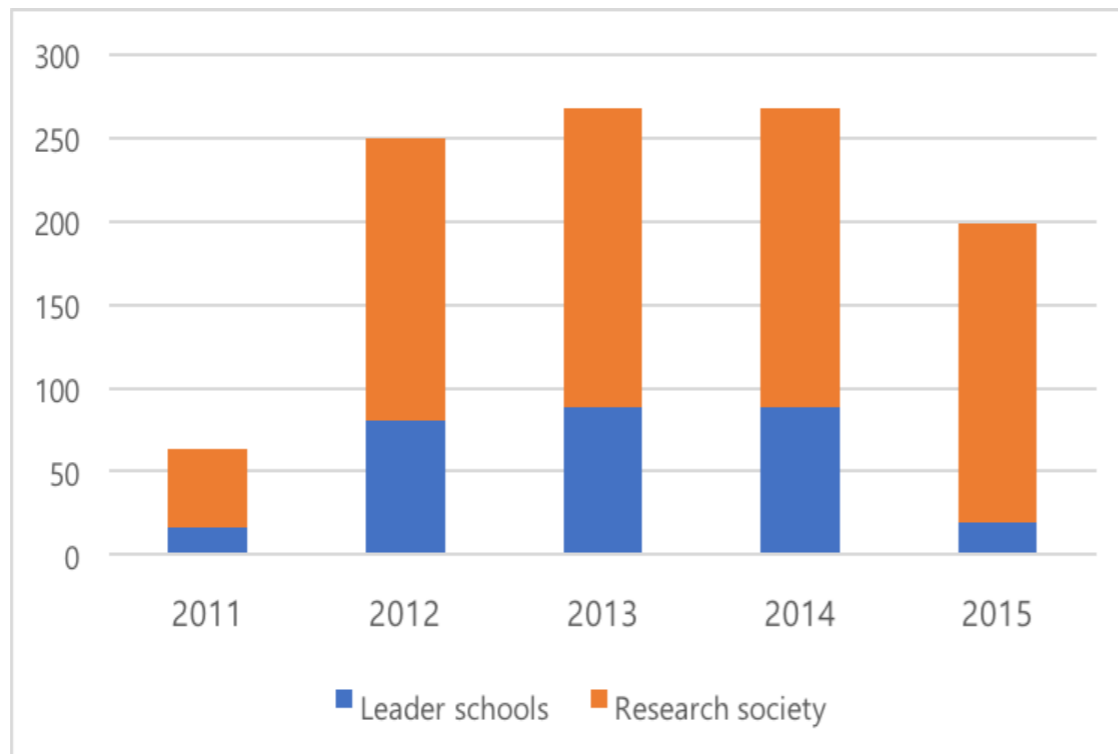


3. Korean Experiences and Implication

C. STEAM education

(1) STEAM Leaders

- **291 Leader schools: STEAM contents at least 20% of total annual class, introduce new contents and methods, dissemination to other schools (regional workshops)**



Block-time

	M	T	W	T	F
1					
2	Math				
3	Sci			Math	
4	Arts			Sci	
5				Arts	

STEAM day

	M	T	W	T	F
1		Math			
2		Sci			
3		Arts			
4		Tech			
5		Sci			

3. Korean Experiences and Implication

C. STEAM education

(1) STEAM Leaders

- 180 STEAM teacher research societies: addresses bottom-up needs and collaboration between teachers (5,000 USD funds)
- KOFAC workshops to share best practices



STEAM leader school

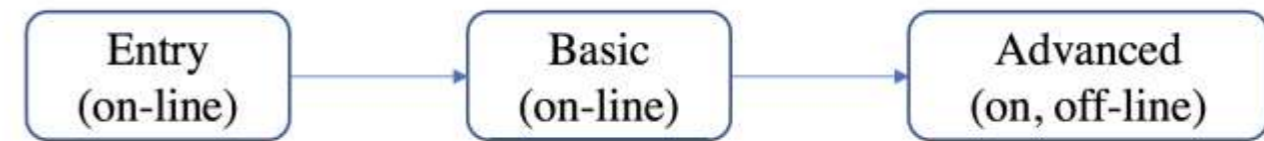


Consulting workshop

3. Korean Experiences and Implication

C. STEAM education

(2) STEAM teacher training



- The advanced stage :10 hrs online & 40 hrs offline training at one of the two Teacher Training Center for Cutting-edge Science in Ewha Womens' University and KAIST
- By 2015, 105,507 (24.7%) among 427,000 teachers completed STEAM teacher training course.
(Online: 102,500; Advanced: 2.408; Oversea: 145; Manger 454)
- In 2016, a new pilot training program for STEAM leader teachers. After 6 month training these teachers will play an important leader role by motoring other teachers, consulting STEAM curriculum development and organizing STEAM teacher conferences.

3. Korean Experiences and Implication

C. STEAM education

(3) STEAM contents development



- 416 new STEAM contents are well linked to the existing textbooks. Recently, KOFAC is developing a STEAM contents map to provide a overall guide reference to teachers.

Type (416)	Topics (example)
Theme convergence (160)	Inclusive technology, Robot, Plant factory
High-tech product utilization (104)	ICT, High-tech medical device, New transportation
Science and Arts integration (108)	Creative manufacturing, Design management
Future career (44)	Big data analyst, Green energy consultant

3. Korean Experiences and Implication

C. STEAM education

(4) Various experience opportunities

- **STEAM Outreach (1) enables students to experience cutting-edge high technology (2) provide future career consulting, and (3) encourage organizations to develop unique STEAM contents using their resources (21 univs, firms, GRIs, Science museums)**

(Example) Korea Institute of Ocean Science & Technology



(1) Craft making using marine litter



(2) Research lab tour



(3) Marine litter collection



(4) Categorizing marine litter



(5) Workbook activities

3. Korean Experiences and Implication

C. STEAM education

(4) Various experience opportunities

- **STEAM with University Students (400 teams):** (1) enhanced the teaching capability of university students, (2) helped school teachers to improve their teaching quality and methodology, and (3) provided school students with an experience-based opportunity
- **Prior-training and consulting at Future STEAM teacher supporting centers (Hangyang, KNUE and Jeju Univs) and wrap-up conference to share best practices**



3. Korean Experiences and Implication

C. STEAM education

(4) Various experience opportunities

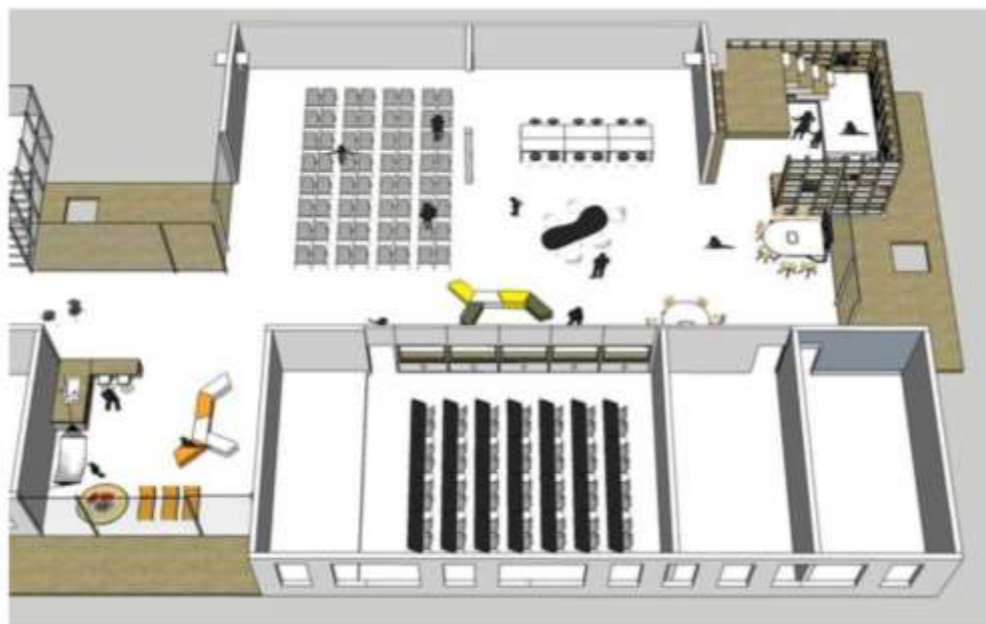
- **STEAM R&E** : a program supporting self-motivated in-depth research activities of school students. Special science high school, STEAM leader school student teams can apply **STEAM R&E**
- **Around 130 teams are selected and each team is funded by 3,500 USD for its STEAM research activity.**
- **Annual STEAM R&E conference is organized and the best teams are given opportunities to attend overseas science competitions, such as The Intel International Science and Engineering Fair (Intel ISEF).**

3. Korean Experiences and Implication

C. STEAM education

(5) Infrastructure

- Evaluating STEAM effects
- Updating and developing new contents and methods
- Establishing STEAM classrooms (32) with smart table, node chair, smart TV , etc.



3. Korean Experiences and Implication

D. STEAM effects: enhanced both performance and motivation

	Mean (St. deviation)		t-value
	Ordinary students	STEAM students	
Interests on science	3.40 (1.14)	3.58 (1.07)	3.39**
Interests on science learning	3.22 (1.19)	3.46 (1.14)	4.68**
Embracing science value	3.85 (1.00)	3.98 (0.95)	3.04**
Confidence in science learning	3.53 (1.06)	3.73 (1.00)	4.16**
Wellness to conduct science assignment	3.06 (1.13)	3.36 (1.08)	6.00**
Wellness to choose science career	2.80 (1.24)	3.08 (1.20)	4.61**

Note: ** p<0.01, * p<0.05;

	Mean (St. deviation)		t-value
	Ordinary students	STEAM students	
Self-motivation	3.24 (1.05)	3.36 (1.00)	2.36**
Cognitive strategy	3.18 (1.04)	3.39 (1.01)	4.50**
Study motivation	2.90 (1.06)	3.14 (1.04)	5.16**
Problem solving willingness	3.30 (1.01)	3.43 (0.98)	2.88**
Tool application	3.33 (1.05)	3.53 (1.00)	4.26**
Collaboration ability	3.40 (1.04)	3.56 (1.02)	3.52**

Note: ** p<0.01, * p<0.05;

Source: KOFAC (2013)

3. Korean Experiences and Implication

E. Excellency track (Science high school – KAIST)

- KAIST : Research Institute + University
- Special S&T oriented Univ established by the special law
 - General Univs by “High Education Act” (MOE)
 - KAIST by “Korea Advanced Institute of Science and Technology Act” (MSIP)
 - UNIST, GIST, DGIST – also by special laws (MSIP)



3. Korean Experiences and Implication

E. Excellency track (Science high school – KAIST)

- **First science high school in 1983**
 - emphasis on excellency and rarity
 - early graduation of excellent students (2 years → KAIST(SNU, etc.), 3 years → other univs.)
 - scholarships (free tuition fees for KAIST)
 - 95% of students → S&T majors (2008-2012)

- **New system : Korea Science Academy of KAIST (STEAM)**
 - Gifted education centers by regional edu offices and univs.

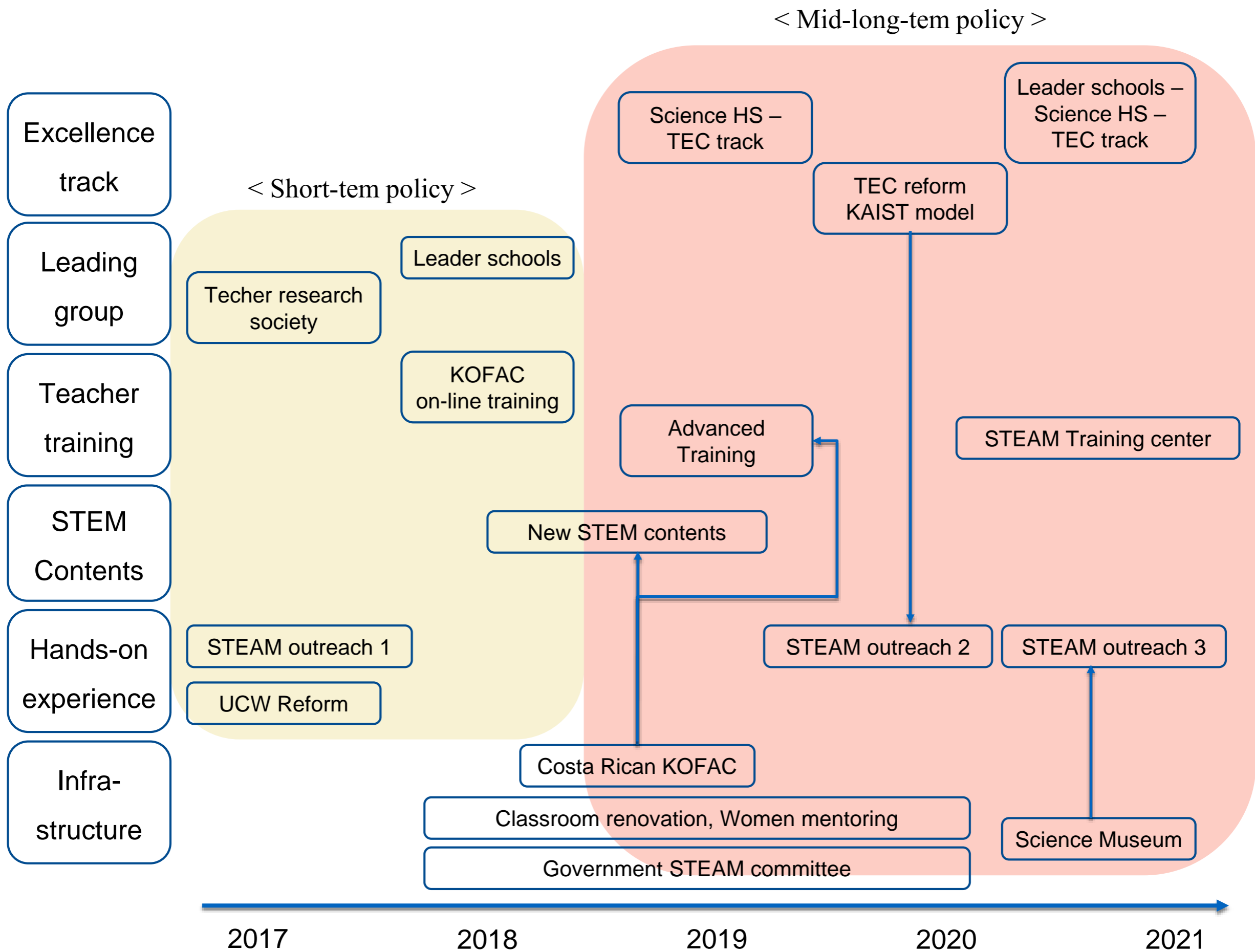
	Science High Schools	Gifted Education Center		Gifted Education Classroom	Total
		Reg. Edu. Office	University		
Institution (#)	27	261	82	2,168	2,538
Proportion (%)	1.1	10.3	3.2	85.4	100

4. Policy Suggestions

A. Why STEAM ?

- **STEAM is a good approach of changing fundamentals of STEM education. In Costa Rica, two tracks, both enhancing quality of STEM subjects and integrating them, has to be conducted simultaneously.**
- **The structure of Korean STEAM policy can be benchmarked, in that it is designed to address all the important issues generally found in education**
- **Therefore, policy suggestions in 6 factors, excellency track, leader groups, teachers, contents, hands-on experience, infrastructure are developed, and time-line is also considered (short vs. mid-long term)**

B. Policy Roadmap



4. Policy Suggestions

C. Hands-on experience

(1) Reform of UCW (University Community Work)

- **UCW (150 ~ 300 hours mandatory volunteer activities) can be restructured to “Costa Rican STEAM with university students program”**
- **University students (who major in S&T) can develop and implement their own STEAM contents**
- **If Costa Rican KOFAC is established, they can be trained and advised systematically.**

4. Policy Suggestions

C. Hands-on experience

(2) STEM outreach

- (Wave 1) encourage CONARE research labs, public universities and private companies
- (Wave 2) TEC can lead the whole program after its renovation (to KAIST model)
- (Wave 3) Science museum can provide many experience-based outreach and afterschool/vacation programs

D. Contents development

(1) New STEAM contents have to be developed and this process can be led by Costa Rican KOFAC

4. Policy Suggestions

E. Teacher training

(1) On-line training

- **The on-line training module of KOFAC can be shortly introduced to Costa Rica, and IDP, FOD or UNED can lead this on-line training program.**

(2) Off-line advanced training

- **Intensive course for STEAM leader teachers can be conducted by Costa Rican KOFAC or Training Centers operated by leading public universities.**
- **Need to introduce qualification (certificate) linked to incentives**

4. Policy Suggestions

F. Fostering leading group

(1) STEAM teacher research society

- **Need to encourage bottom-up capability development by funding and supporting their research**

(2) STEAM leader schools

- **Leader schools can play a regional hub for STEAM**
- **Possible benefits for leader schools**
 - **UCW and Outreach priority allocation**
 - **Advanced training course priority application**
 - **New STEAM contents priority application**
 - **Supporting STEAM classroom reformation, etc.**

4. Policy Suggestions

G. Special track for scientific high schools

- It is necessary to develop strong incentives, such as the introduction of special university admission system or special scholarship
- In the long-run, the transformation of TEC (and/or UTN) to KAIST has to be considered (a special law managed by MICITT)
- Though this, STEAM pipeline, “STEAM leader school – Scientific High School – TEC” has to be established

4. Policy Suggestions

H. Infrastructure establishment

(1) Costa Rican KOFAC (Special STEAM organization)

- A new organization or FOD role expansion
- Suggested main role of Costa Rican KOFAC
 - Developing STEAM education contents
 - Training (and re-training) STEAM teachers
 - Planning and implementing various STEAM activities
(STEAM teacher research group, STEAM UCW and Outreach)
 - Supporting Women student STEAM
 - Promotion of S&T culture

4. Policy Suggestions

(2) Systematic collaboration platform between Ministries

- **PRONAFECYT has been an effective STEAM event, but it is based on an official agreement between MEP and MICITT**
- **For sustainable collaboration, it is necessary to develop a structured collaboration platform**
 - **A comprehensive long-term agreement**
 - **Establishment of “An Act of STEAM education”**
 - **A Special Presidential Committee for STEAM education (MICITT, MEP, Universities, IDP, teachers, etc.)**

(3) Establishment of Science Museum

(4) Women mentoring programs



THANK YOU



KNOWLEDGE SHARING PROGRAM