



**Josip Juraj Strossmayer
University of Osijek**

ON CONTEMPORARY ENGINEERING EDUCATION

Prof.dr.sc. Damir Markulak

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**ARE YOU SATISFIED WITH THE
PRESENT STATE OF
ENGINEERING EDUCATION?**

CURRENT ENGINEERING EDUCATION BASED ON:

- traditional system of KNOWLEDGE TRANSFER
 - more or less authoritative professor-student relationship
- significantly reduced ELITIZATION of knowledge
 - information is now available for anyone!
- use of more modern teaching TOOLS
 - presentations, multimedia sources etc.
- education mainly through specialist trainings
 - for example in CE divisions according to building materials
- generally there is no significant multidisciplinary or team-work
 - students rarely need to contact several professors for solving assignments
- the main principle:
 - one-size-fits-all education



'LINEAR' SYSTEM OF EDUCATION



Current level of Knowledge



Separate Knowledge



(mainly) traditional learning methods

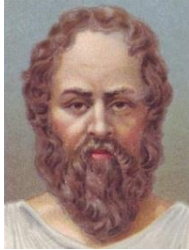


BUSINESS & INDUSTRY SECTOR



- ❑ strongly STATIC process without too many 'interruptions'
- ❑ in the focus 'AMOUNT' of knowledge that should be poured 'into' the students
- ❑ specialised knowledge without 'DEPTH' → to know everything about nothing
- ❑ 'ANALOG' transmission of sets of information → congestion, difficult linking
- ❑ formation of ISLANDS OF KNOWLEDGE → individuals operate separately
- ❑ showing what's been learnt mostly by mere REPRODUCTION → low-level learning

IS THAT WHAT WE WANT?



SOCRATES:

'Education is the kindling of a flame, not the filling of a vessel.'



A NEED TO CHANGE THE EXISTING PARADIGM OF ENGINEERING EDUCATION!

Strategic thinking:

WHAT → WHY → HOW → WHERE → WHO



EDUCATE AND TRAIN ENGINEER OF THE FUTURE CAPABLE TO SUCCESSFULLY DEAL WITH THE CONTEMPORARY AND FUTURE PROFESSIONAL CHALLENGES.

THE TRUTHS

(not so comforting, but good for us to be aware of in the beginning):

1. There is NO education system, no matter how sophisticated and comprehensive it may be, to fully prepare students for what is ahead of them once they finish studies and face their professional tasks

→ LEARN (yourself and the students) TO MAKE DECISIONS WHEN THERE IS NO ALL INFORMATION AVAILABLE (Pareto principle – 80/20 Rule)

2. We have to put our attention to the fact that contemporary education market becomes more and more challenging, taking knowledge as a 'product' that has to meet the usual requirements that also apply to other products - for example:

- a certain level of quality, functionality, usability, durability
- it must have a 'unit of measure'
- it has to find its place on the market
- its properties should be monitored, tested and approved (QA system)
- It has to be sustainable and so on.



→ CONSIDERING THE PROBLEM THAT WAY MAKES IT EASIER TO CREATE OR MODIFY OUR STUDY PROGRAMMES AND LEARNING OUTCOMES

WHY? CONTEMPORARY ENGINEERING PROFESSION

- ❑ more demanding, complex, long lasting and comprehensive projects that have to be considered from various aspects – financial, social, environmental, economics, political etc.
- ❑ urge for using new/modified/improved materials, sustainability
- ❑ strong impact of ever-developing technology both in design process and application (construction..etc.)
- ❑ a growing need for remediation of consequences of modern capitalism – overcrowded cities, disfunctional traffic and utility infrastructure, large amounts of waste, lack of drinking water, forest devastation, drastic climate change and following disastrous events – earthquakes, flood, hurricanes, tidal waves etc.)
- ❑ overlapping and/or redefinition of the boundaries between professional fields
- ❑ a need for abilities and skills other than narrow professional ones
- ❑ complex and high-demanding modern professional design codes
- ❑ an accelerated need for upgrading and perfecting our personal knowledge and skills
- ❑ ability to adapt or re-invent the very nature of engineering field

HOW TO ACCOMPLISH OUR GOAL?

A. EINSTEIN: 'Problems cannot be solved at the same level of awereness that created them.'

❑ GENERAL APPROACH

→ CHANGE THE PERSPECTIVE!

❑ STUDY PROGRAMMES

→ PROVIDE THE FRAMEWORK FOR THE NEW PERSPECTIVE

❑ KNOWLEDGE TRANSFER METHODS

→ ADAPT, IMPROVE AND MODERNIZE

❑ RELATION BETWEEN STUDENTS AND TEACHERS

→ RECONSIDER, CLARIFY AND THEN RESPECT!

GENERAL APPROACH

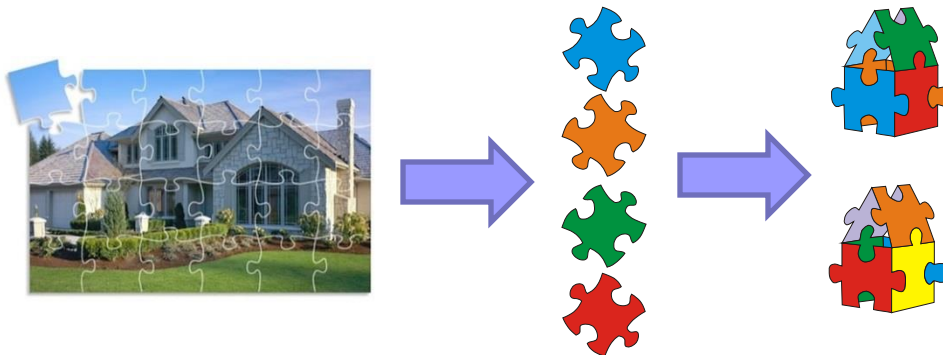
(valid for all levels)

- ❑ BUILD 'BRIDGES' – keep defining links for various elements to become parts of larger whole → openness, cooperation, team-work, synergy
- ❑ ADOPT AN INTEGRAL APPROACH - consider a person as the whole
- ❑ THINK INTERDISCIPLINARY – approach the problem from various aspects
- ❑ ASSURE SUSTAINABILITY – consider life-long cycles, recognize the long-term impacts that are being achieved
- ❑ OFFER as many OPPORTUNITIES as it is possible TO CONNECT HIGHER EDUCATION, SCIENTIFIC AND PRACTICAL KNOWLEDGE
- ❑ ESTABLISH THE MECHANISM OF FEEDBACK COLLECTING – monitor, collect and analyse data → QA system → keep reshaping the system

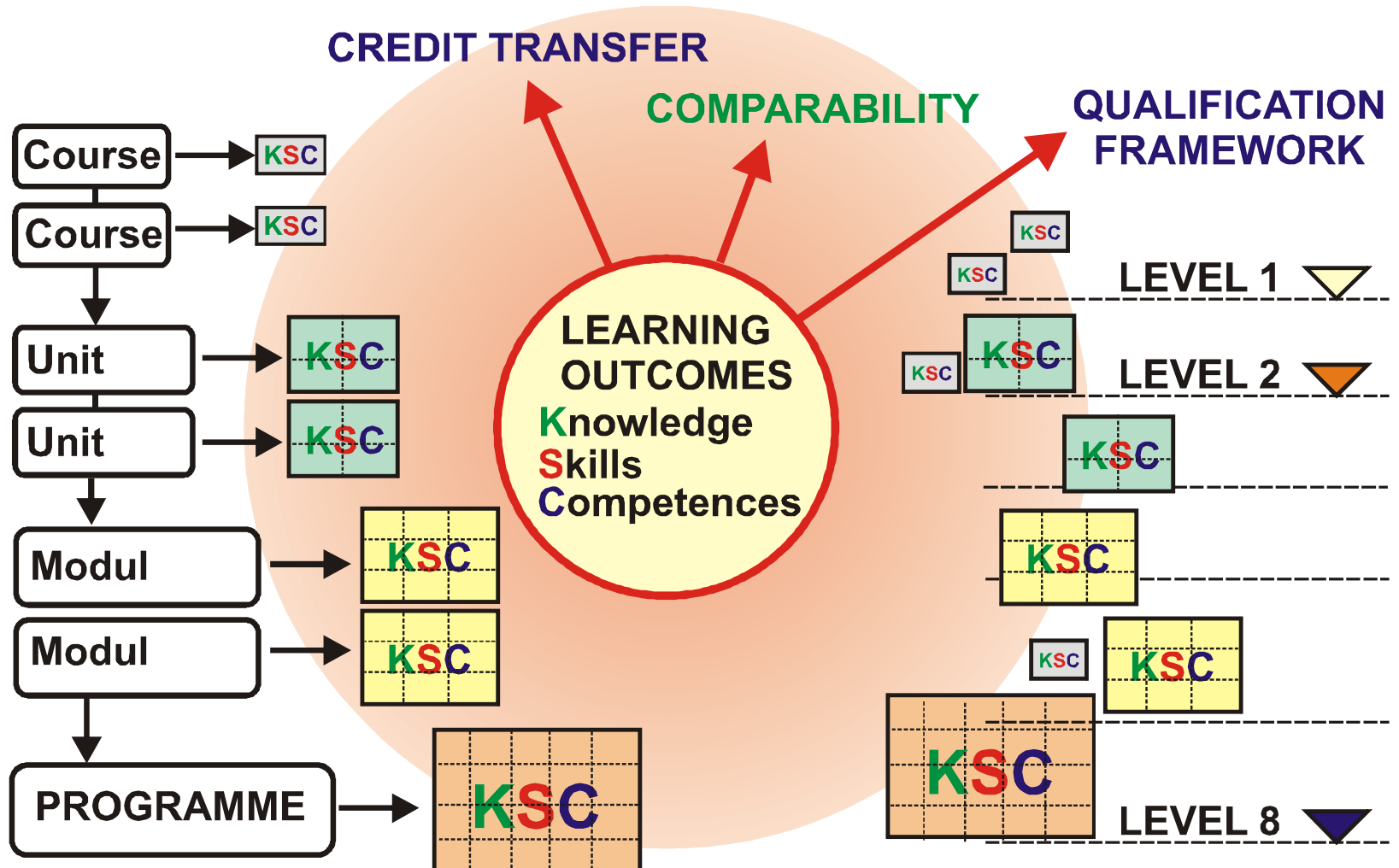
STUDY PROGRAMMES



- ❑ PRECISE definition of learning outcomes in terms of knowledge, skills and competence within The national qualifications framework taking into account comparability to the similar national and international higher educational institutions
- ❑ LEARNING OUTCOMES as 'units of measure'/'building blocks' that can be easily connected into a larger meaningful whole



- Enable EQUALIZATION of using 'Bologna tools' – ECTS system, diploma supplement and qualifications framework → remove obstacles for mobility



❑ Rather than BE OCCUPIED with AMOUNT OF KNOWLEDGE allow **FLEXIBILITY** in courses:

- provide ENOUGH **TIME** for the students to discuss, connect and review the lecture content
- apart from obligatory tasks support opportunities for assignments created according to **PERSONAL** INTEREST and PREFERENCE
- encourage **JOINT** COURSES/PROGRAMMES/DEGREES
- ASSURE **DIVERSITY** in presenting the lecture content that will help to keep students' interest in course (workshops, guest teachers, students' presentations, multimedia time, fieldwork etc.)
- try '**DIGITAL**' transmission of data: present quantitatively less but qualitatively more **TARGETED** information



- **ANTICIPATE OPPORTUNITIES** for **LINKING** education process more closely to the **BUSINESS** sector as well as **SCIENTIFIC** research
 - give students opportunity **TO APPLY** acquired theoretical knowledge in real circumstances and constrains
 - provide possibilities for **STUDENT'S PARTICIPATION** in laboratory testing, numerical modelling or other parts of scientific reserach
 - collect **VALUABLE FEEDBACK** information about actually realized learning outcomes



-and the most important, **ULTIMATE GOAL:**

TEACH STUDENTS TO LEARN!

- National Academy of Engineering, Washington, DC: The Engineer of 2020:
*'ENGINEERS ARE GOING TO HAVE TO ACCEPT RESPONSIBILITY FOR THEIR OWN CONTINUAL REEDUCATION, AND ENGINEERS SCHOOLS ARE GOING TO HAVE TO PREPARE ENGINEERS TO DO SO BY **TEACHING THEM TO LEARN**.'*

**Give a man a fish,
he'll eat for a day.
Teach a man to fish,
he'll eat for life.**

Lao Tzu



VELIKO ISTRAŽIVANJE MEĐU UČENICIMA 4. I 8. RAZREDA

PISJE MIRELA LILEK

Bez obzira na to imaju li u osnovnoj školi zaključene dvojke, trojke, četvorke ili petice, u prosjeku 83 posto današnjih 14-godišnjaka želi jednoga dana upisati studij. Pritom su djevojčice ambicioznije: na fakultet ih želi 88 posto - naspram 77 posto dječaka.

Podatak da želi studirati i 70 posto učenika koji su iz najbitnijih predmeta u sedmom razredu imali zaključene trojke, a istu želju ima i više od trećine učenika kojima je iz matematike, hrvatskog i stranog jezika zaključena dvojka, zabrinuo je istraživače.

Izrazit nesklad

Premda se činjenica da je studiranje postalo univerzalan cilj može činiti pozitivnom, ona je, kažu, istovremeno zabrinjavajuća jer za značajan dio učenika visoka očekivanja mogu biti i izvor frustracija. Posebno za učenike koji u osnovnoj imaju prosječan ili ispodprosječan uspjeh, a istovremeno se nadaju da će njihov obrazovni put trajati još desetak godina.

- U kombinaciji s relativno slabo razvijenim navikama učenja i činjenicom da obrazovni sustav ne uči učenike kako učiti, takve aspiracije mogu imati i negativne društvene posljedice - smatraju Zrinka Ristić Dedić i Boris Jokić s Instituta za društvena istraživanja u Zagrebu, koji su proveli prvo istraživanje ove vrste na populaciji 4716 učenika četvrtih i osmihih razreda.

U istraživanju "O učenju 2014." koje je obuhvatilo svih 109 osnovnih škola u Zagrebu ističe se podatak po kojemu 80 posto djece tvrdi: "Roditelji očekuju da ću jednoga dana ići na fakultet". Čak i onda kada dijete u sedmom razredu ima zaključenu kombinaciju ocjena ključnih predmeta dovoljan, dovoljan i dobar, više od 50 posto učenika tvrdi da njihovi roditelji očekuju da će

Zrinka Ristić Dedić i Boris Jokić s Instituta za društvena istraživanja, autori istraživanja



MARIKO TUDOROVIC/ROPIX

'Loše ocjene nisu važne, moramo upisati fakultet jer to žele naši roditelji'

Autori istraživanja: Problem će nastati jer slabije uspješni učenici nemaju naviku učenja, a obrazovni sustav ih ne uči kako učiti

s podacima o navikama učenja koje pokazuju da gotovo dvije trećine učenika uči isključivo prije pismenog i usmenog ispita, a više od 40 posto često ili gotovo uvijek

prepisuje domaće zadaje - kažu istraživači.

Nerealne želje

Michelle Braš Roth, PISA menadžerica za Hrvatsku, pro-

cjenjuje da je želja 83 posto osnovaca da jednoga dana studiraju dijelom razumljiva zbog činjenice da srednjoškolska razina više nije dovoljna današnjem tržištu rada, a tzv. plavi ovratnici, radnička, odnosno industrijska zanimanja, uglavnom su izgubljeni. No, želje su, kaže, i nerealne.

- Našem tržištu rada i nije potreban toliki broj visokoobrazovanih stručnjaka. Želja za masovnim upisom studija je i riskantna. Većina današnjih mladih može sa sigurnošću očekivati da će njihova zanimanja tijekom vijeka nestati, a nastat će nova. To znači da će se oni morati dodatno obrazovati

programima škola i studija. Istraživanje se pozabavilo i pitanjem koju vrstu srednjoškolskog obrazovanja žele osnovci. U prosjeku 46 posto djece bira gimnaziju naspram njih 36 posto koji žele četverogodišnje strukovno obrazovanje.

Djevojčice bi gimnazije

Dok djevojčice u višem postotku biraju gimnazije, dečcima je izbor između strukovnog obrazovanja i gimnazija gotovo postotkom identičan (40-40). Da je trogodišnje škole na neki način pregazilo vrijeme daje do znanja podatak da te programe želi upisati samo 7,7 posto osnovaca. Trenutačno, tek svaki dru-

88%
14-godišnjakinja želi na studij

40%
učenika često ili gotovo uvijek prepisuje zadaje

80%
roditelja želi da njihovo dijete studira

46%
učenika želi upisati gimnaziju

36%
strukovnu školu

8%
djece želi u trogodišnju školu

MINISTAR OBRAZOVANJA MORNAR:

'VELIKIH ĆE PROBLEMA IMATI NA FAKULTETU'

- Nakon srednje škole oko 75 posto generacije uspije upisati fakultet, no onda počinju problemi jer je drop outna studiju dalje visok. S druge strane, odličnostima se pod-

daju iz osnovnih i srednjih škola. Mislim da je problem u strukovnom obrazovanju koje danas nije ono što je trebalo biti, a to je da proizvodi kadar za tržište rada. Umjesto toga, strukovnjaci masovno upisuju studije - kaže Vedran

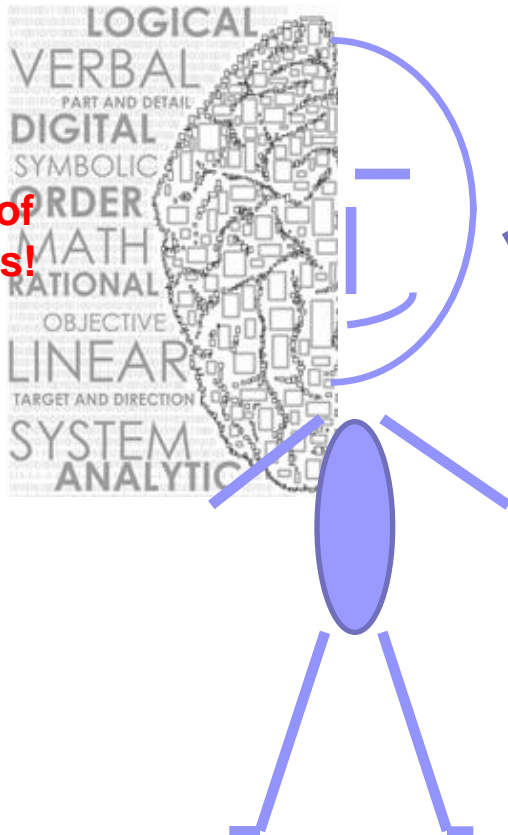


- 4716 pupils, all 109 primary schools in Zagreb were included into research

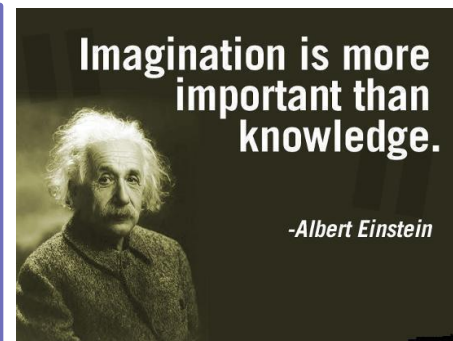
KNOWLEDGE TRANSFER

- ❑ **TECHNOLOGY ALONE IS NOT ENOUGH** → significant improvement in knowledge transfer process requires a deep understanding of **HUMAN BEHAVIOUR**
 - Approach based on considering a student as **the 'whole' person** rather than mainly focusing on intellectual level

The only concern of our marks!



+



Try to provoke full reflection on problems!

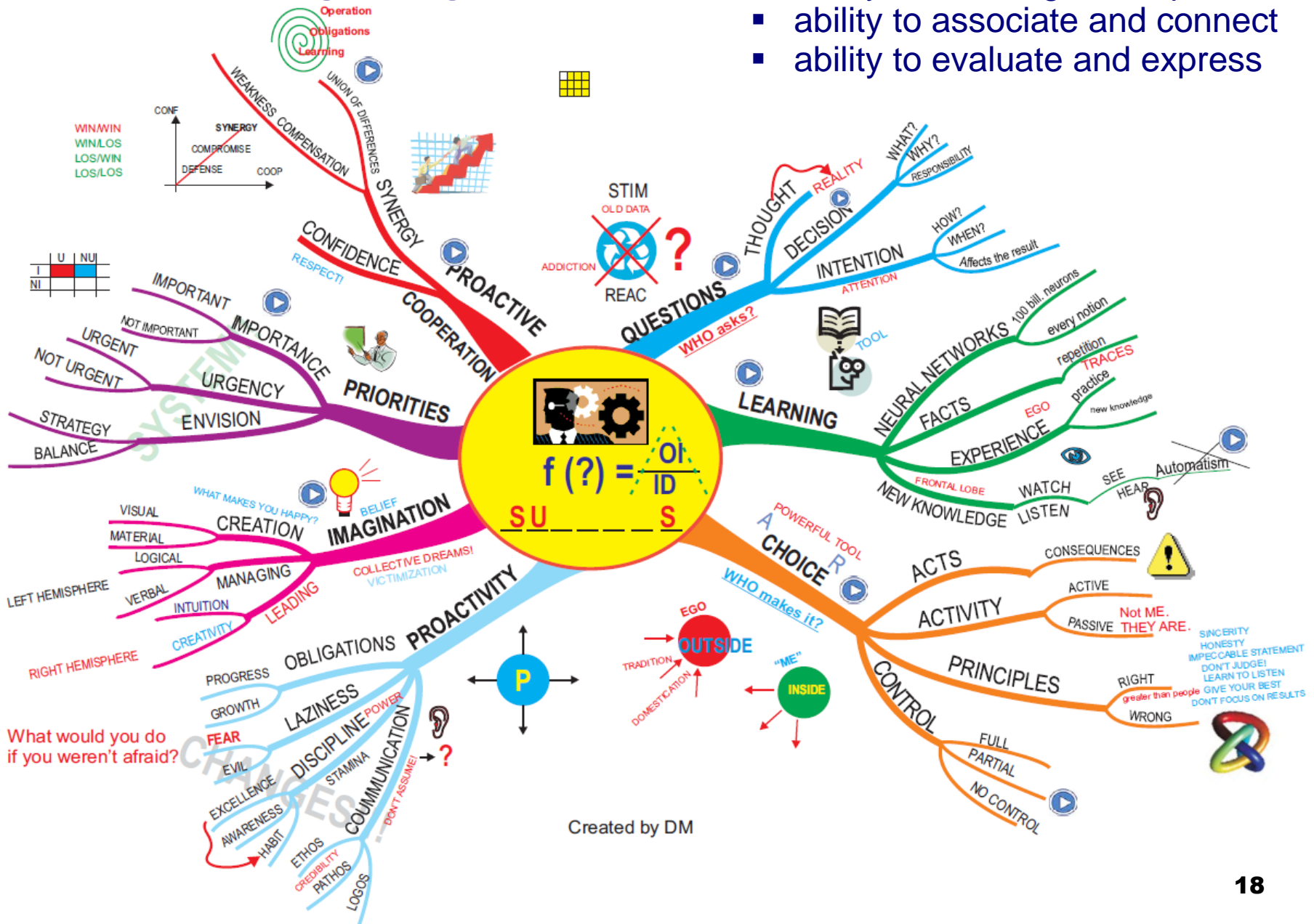
- pave the way for awakening of ‘WILLING FACTOR’ instead of dwelling on ‘WANT FACTOR’ – nurture students’ self-motivation, determination and consistency so that they create integral learning frame and sense of **RESPONSIBILITY** for their own work

- P. Salovey: *Emotional intelligence is the subset of social intelligence that involves the ability to monitor one’s own and others’ feelings and emotions, to discriminate among them and to use this information to guide one’s THINKING AND ACTIONS.*
 - along with professional skills help students to develop meta-competencies (‘soft’, ‘lateral’ skills) required of twenty-first-century engineer:
 - ABILITY TO MANAGE INFORMATION
 - ABILITY TO MANAGE THINKING
 - ABILITY TO MANAGE COLLABORATION
 - ABILITY TO MANAGE ATTITUDE

Peggy Klaus: ‘Soft Skills get little respect, but will make or break your career’.

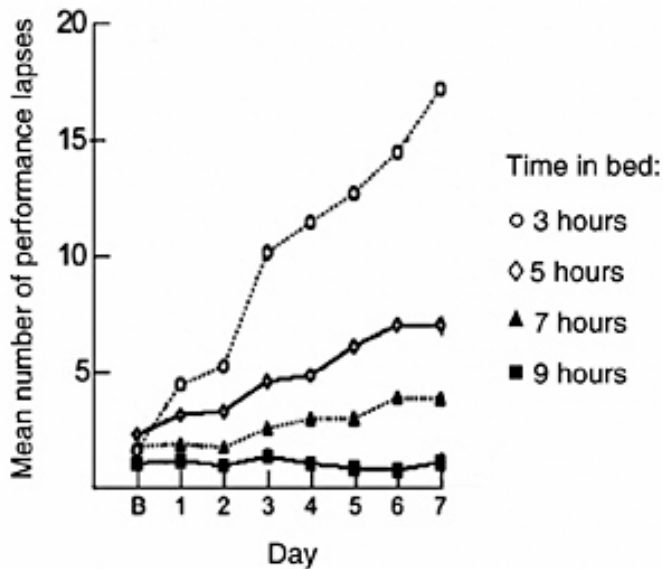
PROVOKE higher cognition activities:

- ability to challenge and question
- ability to associate and connect
- ability to evaluate and express



ACCOUNT for changing behavioural patterns in younger generation

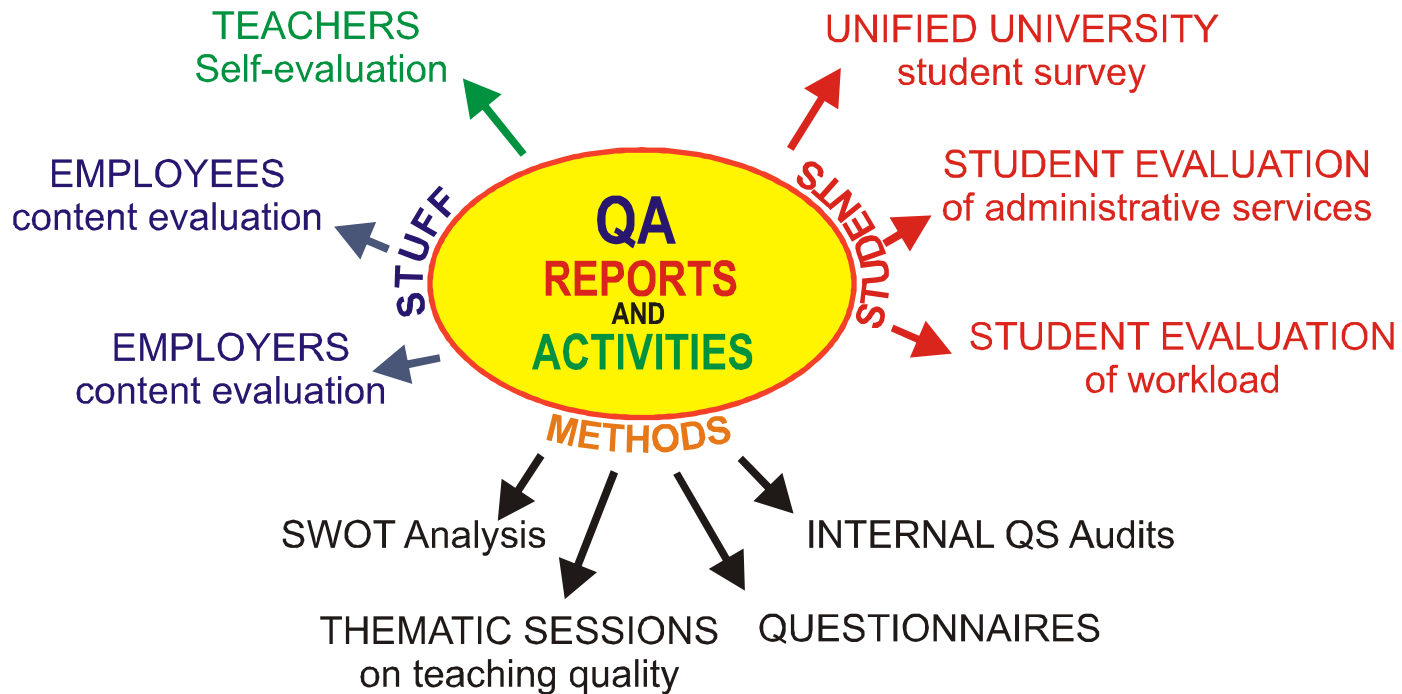
- American National Institutes for Health: *College students are one of the most **sleep-deprived** populations*
- Game-driven generation
- Strong dependence on social networks ('it hasn't really happened until it has been posted on...')
- Lack of attention...



Belenky at al., 2003



- CONTINUOUSLY monitor and analyse education system functioning (QA)

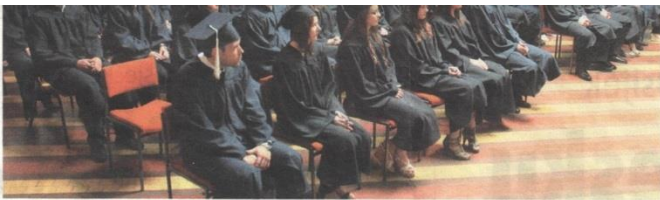


- OPPORTUNITY to keep track of current efficiency and goal achievements as well as detecting problems

Example: FCE Osijek → phenomenon so-called 'Backward studying'

Due to more relaxed entry into studying in the first year (low credit threshold), students struggle to catch up with their growing obligations afterwards and find themselves fully stucked in the third year.

→ Action undertaken: CREDIT TRESHOLD **RAISED** from 42 to 50 ECTS



VODSTVO GRAĐEVINSKOG FAKULTETA povećalo prag za upis u višu godinu studija

Studentski zbor: 50 bodova je previše, studenti će padati!

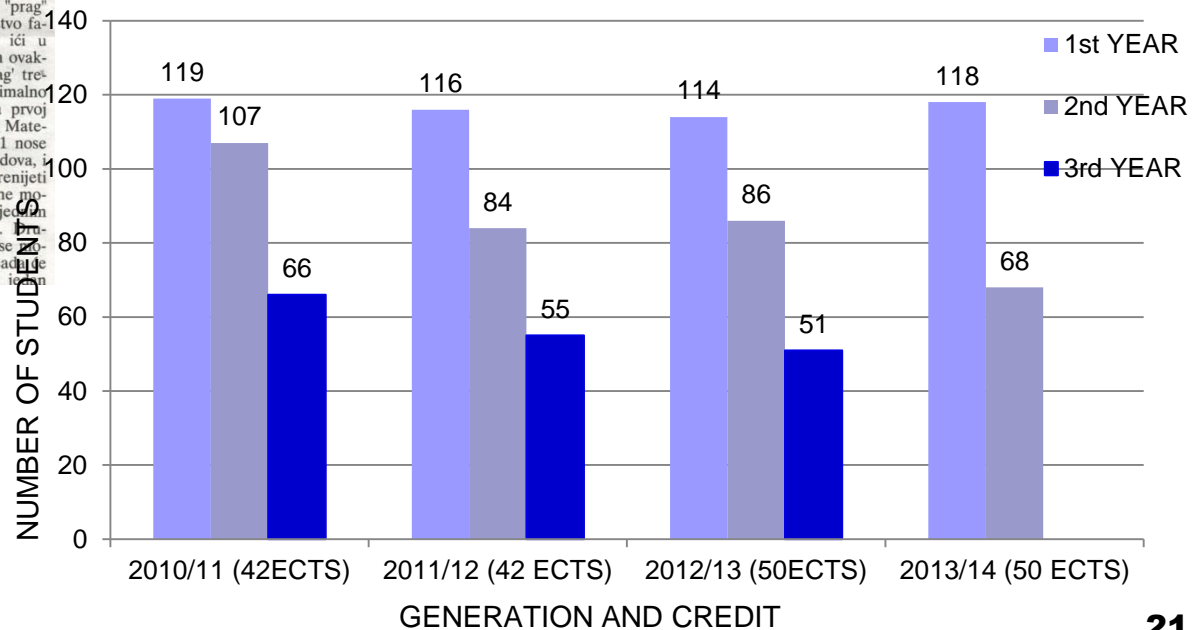
Tomislav LEVAK

To činimo isključivo u korist studenata, kaže dekan Građevine Damir Markulak

pojasnio je razlog za ovakvu izmjenu. "To činimo isključivo u korist studenata. Naime, oni su po dosadašnjim uvjetima još uspijevali upisati 2. godinu studija, ali onda su najčešće nastajali problemi jer je mnogima, zbog prenošenja velikog broja ECTS bodova, ostajalo previše ispita. Stoga na višim godinama nisu uspijevali ispunjavati uvjete pa bi ili ponavljali godine ili bi im se vrijeme studiranja produžilo. Vjerujemo da će ovaj potez polučiti pozitivne rezultate", kaže Markulak. Tvr-

slaze se kako je novi "prag" previsok. "Ako je vodstvo fakulteta zaista željelo ići u korist studenata putem ovakve mjere, onda je 'prag' trebalo povisiti na maksimalno 46 ECTS bodova. Na prvoj godini najteži ispiti, Matematika 1 i Mehanika 1 nose osam, odnosno šest bodova, i oni bi se tako mogli prenijeti u kombinaciji, a sada ne mogu, praktički čak ni s jednim drugim težim ispitom. To drugim riječima, do sada se moglo prenijeti tri, a od sada se praktički moći samo jedan

De Koning et al.: 'Impact of binding study...' (2014): 'Introduction of a credit threshold results in a positive change in study behavior'.



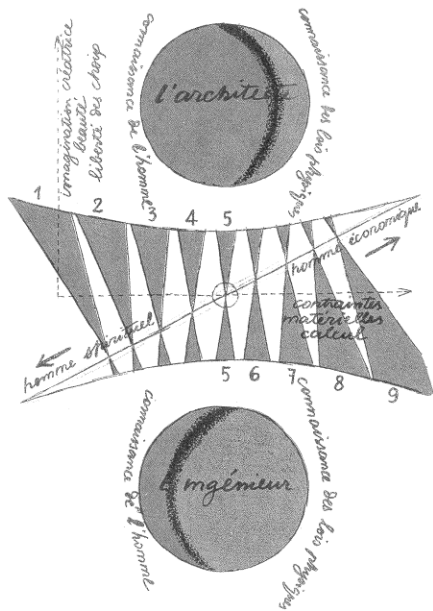
STUDENT-TEACHER RELATIONS

- Recently **STRONG ACCENT** on shifting the role of teachers/instructors to orchestrators/facilitators of learning and more extensive including students into courses' planning
 - **BE CAREFUL with ENGINEERING!**
- We should strive for partnership and mutually respectful relationship based on **TAKING RESPONSIBILITY FOR THEIR OWN ACTION**
 - **It is unavoidable condition for SUSTAINABILITY.**

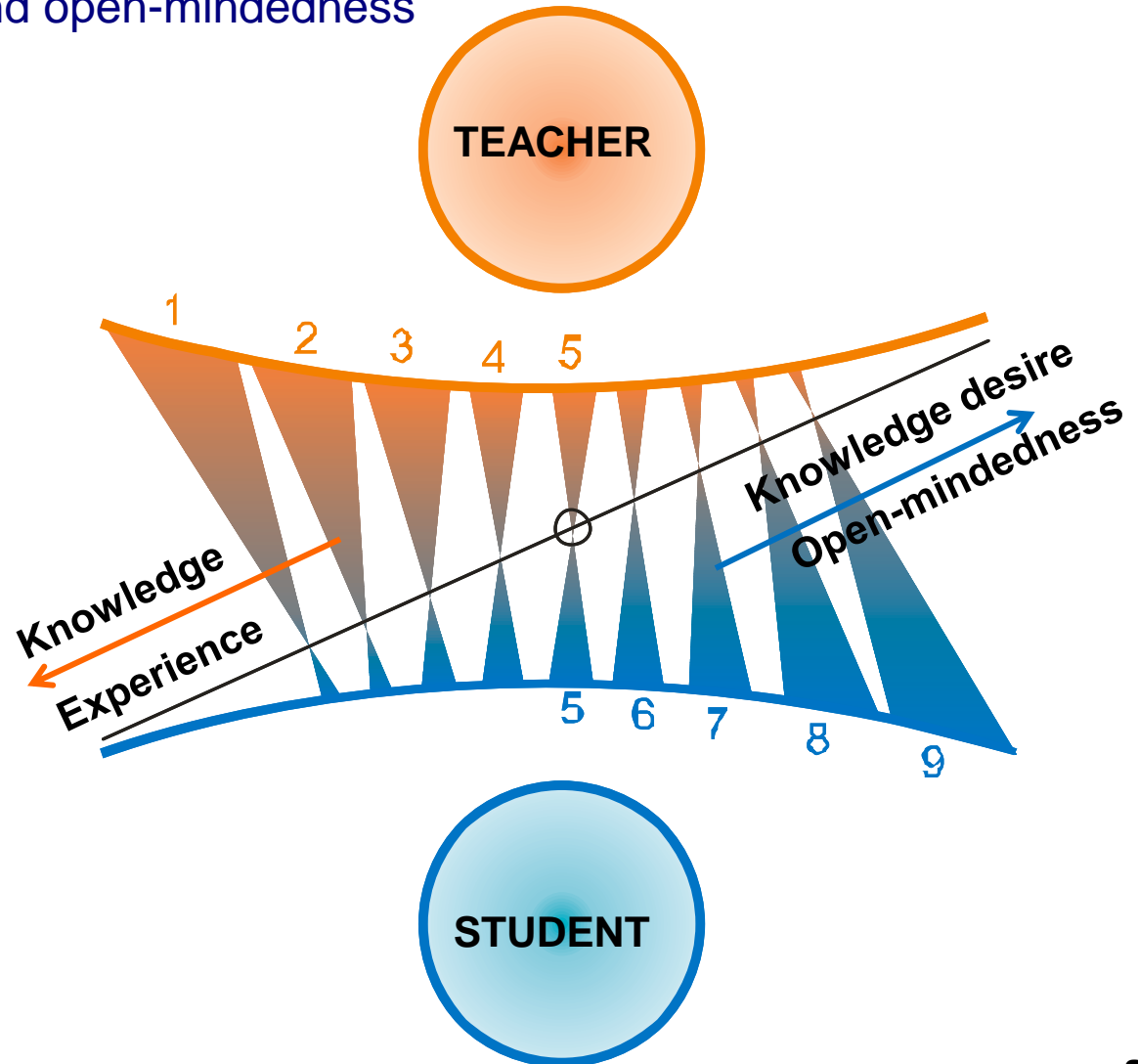
Anne Frank: 'Our lives are fashioned by our choices. First we make our choices. Then our choices make us.'
- Five 'Es' of an excellent university teacher:
 - EDUCATION
 - EXPERIENCE
 - ENTHUSIASM
 - EASE
 - ECCENTRICITY



- We don't need isolated poles but **advanced combination** of:
 - Knowledge and desire of knowledge
 - Experience and open-mindedness



Le Corbusier (1887.-1965.)
– relation between architects
and engineers

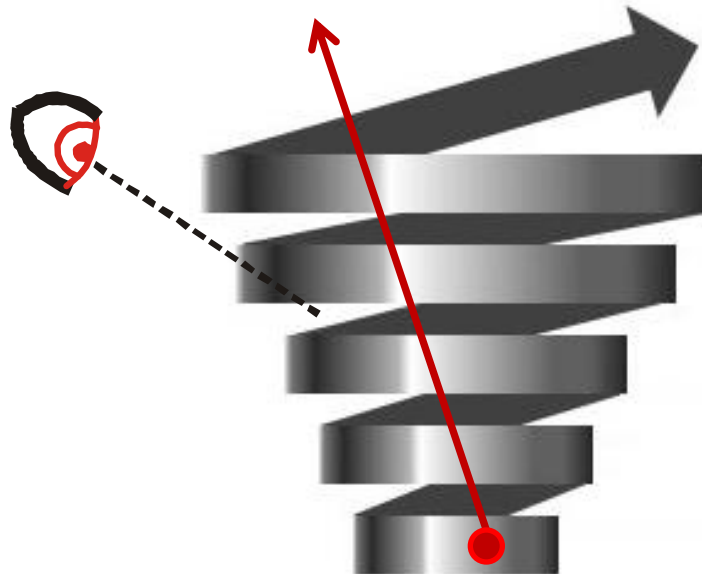


Epictetus: 'It is impossible for a man to learn what he thinks he already knows.'

So, WHAT we need is...

‘SPIRAL’ MODEL OF EDUCATION

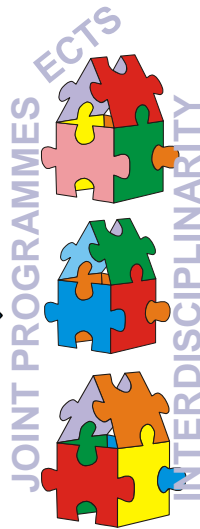
- The SPIRAL symbolizes continuous growth through dynamic, self-evolving process → not ONLY replicate and evolve but also DESIGN THEIR OWN EVOLUTION by choosing and inventing the direction of their own development
- The process should come back around the beginning point but at a HIGHER, different LEVEL (as a consequence of the new knowledge/experience/awareness), seeing everything **IN A NEW PERSPECTIVE**



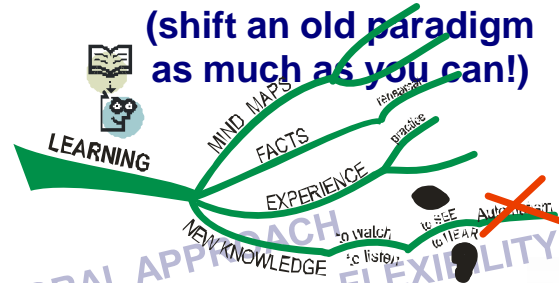
CURRENT LEVEL OF KNOWLEDGE



KNOWLEDGE MODULES
(as a function of desired learning outcomes)



EDUCATION PROCESS
(shift an old paradigm as much as you can!)



BUSINESS & INDUSTRY SECTOR



INTEGRAL APPROACH
LOGICAL, VERBAL, DIGITAL, ORDER, MATH, NATIONAL, SYSTEM, ANALYTIC



EDUCATION POLICY MAKING
STAKEHOLDERS

GOVERNMENT DEPARTMENTS
COMUNITY ALUMNI

REDIRECT SYSTEM FROM A NEW PERSPECTIVE (keep, modify, reshape, adapt, change, revoke...)

FEEDBACK INFORMATION
(QA: collect, analyze, understand and TASK!)

CONCLUDING REMARKS

- WE HAVE TO **CHANGE** OUR CURRENT **PERSPECTIVE** (=MIND-SET) ON ENGINEERING EDUCATION
- THE BEST WAY FOR DOING IT IS TO APPLY '**STRATEGIC THINKING**' METHOD (What? Why? How?...). IT IS VALID AT ALL LEVELS (an idea, a person, a group.a system)
- UNDERSTANDING OF **HUMAN BEHAVIOUR** IS CRUCIAL FOR IMPROVING KNOWLEDGE TRANSFER PROCESS
- THE KEY TASK IS **TO TEACH STUDENTS HOW TO LEARN** AND TAKE RESPONSIBILITY FOR THEIR OWN CONTINUAL RE-EDUCATION (LLL)
- **COMPLEMENTING** KNOWLEDGE AND DESIRE OF KNOWLEDGE, EXPERIENCE AND OPEN-MINDEDNESS WILL BOOST DEVELOPMENT
- SELF-SUSTAINING AND SELF-IMPROVING '**SPIRAL**' SYSTEM OF EDUCATION SHOULD BE RUN BY MOTIVATING FACTORS FOR ALL PARTIES

ENGINEERS HAVE CHANGED THE WORLD, BUT THE TIME HAS COME FOR THE WORLD TO CHANGE ENGINEERS



THANK YOU FOR YOUR ATTENTION!

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