To Choose STEM or not: What Inspires Young People to Make Life Choices in STEM?

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Overview of Lecture

- Why is STEM choice an issue?
  - UK, Europe, worldwide
- What do we know about influences on choice?
  - Research studies show multiple factors
- Theoretical perspectives
  - Attitudes, motivation, self-concept, identity
- Two projects:
  - Chemistry for all
  - Promoting Youth Career Awareness and Attractiveness through Multi-stakeholder Co-operation (MultiCo)

Why is STEM choice an issue?

- STEM = Science, Technology, Engineering, Mathematics: (my focus will be science)
- Relatively low numbers of students choose to study physical sciences post-16.
- There is under-representation of certain groups (factors include: social class, gender, ethnicity).
- Students from poorer families are found to be less likely to take sciences than other subjects (Gorard, S. & See, B. H. (2009) The impact of socio-economic status on participation and attainment in science. *Studies in Science Education*, 45(1), 93-129).
- Few young people aspire to become a scientist.

What do we know about influences on choice?

- Students receiving encouragement by key people in their lives (parents, teachers).
- Students believing they will gain something from studying science, either from job satisfaction or through material benefit.
- Students having confidence in their knowledge.
- Students being inspired by good teaching.

What do we know about influences on choice? The work of ASPIRES.

- Families exert an influence on students' aspirations.
- Most young people and parents are not aware that science can lead to diverse post-16 routes.
- The widespread view – that science qualifications lead primarily to a job as a scientist, science teacher or doctor – is contributing to many young people seeing post-16 science qualifications as not relevant to them.

Archer, L. *et al.* (2013) *ASPIRES: Young people's science and career aspirations, age 10-14*. London: King's College.

Theoretical perspectives

- Attitudes to science
- Motivation and interest
- Self-concept
- Identity
- Expectancy value
- Science capital
  - Archer, L., Dawson, E., DeWitt, J., Seakins, A. & Wong, B. (2015) "Science capital": A Conceptal, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts. *Journal of Research in Science Teaching,* 52(7) 922-948.

Key articles on choice

- Bøe, M. V., Henriksen, E. K., Lyons, T. & Schreiner, C. (2011). Participation in science and technology: young people's achievement-related choices in late-modern societies. *Studies in Science Education,* 47(1), 37-72.
- Cleaves, A. (2005). The formation of science choices in secondary school. *International Journal of Science education*, 27(4), 471-486.
- Holmegaard, H. T., Madsen, L. M., & Ulriksen, L. (2012). To choose or not to choose science: Constructions of desirable identities among young people considering a STEM higher education programme. *International Journal of Science Education*, 36(2), 186-215.
- Korpershoek, H., Kuyper, H., Bosker, R. & van der Werf, G. (2012) Students leaving the STEM pipeline: an investigation of their attitudes and the influence on significant others on their study choice. *Research papers in Education*, 28(4), 403-505.
- Sjaastad, J. (2012) Sources of inspiration: the role of 'significant persons' in young people's choice of science in higher education. *International Journal of Science Education*, 34(10), 1615-1636.
- Tan, E., Calabrese Barton, A., Kang, H. & O'Neill, T. (2013) Desiring a career in STEM-related fields: how middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching*, 50(10), 1143-1179.

Key edited text

- Henriksen, E. K., Dillon, J. & Ryder, J. (Eds.). (2015). *Understanding Student Participation and Choice in Science and Technology Education.* Dordrecht: Springer.

Project 1: Chemistry for all

- Funded by the Royal Society of Chemistry (RSC)
- *www.rsc.org*
- Aims to widen student participation in chemistry by providing interventions for students aged 12 – 16 over a four year period.
- Interventions include in-school and out-of-school activities that stimulate students' interest and engagement in chemistry.

Chemistry for all: Universities

- Four universities have a programme of intervention activities:
- Liverpool John Moores University
- Nottingham Trent University
- Reading and Southampton University consortium
- Each university works with 6 schools where the student population has below average attainment, and where there are high numbers of disadvantaged students.


North Yorkshire
York
Humberside
Lancashire
West Yorkshire
Greater Manchester
Merseyside
Liverpool
South Yorkshire
Lincoln
Cheshire
Nottinghamshire
Lincolnshire
Clwyd
Gwynedd
Derbyshire
Staffordshire
King's Lynn
Leicester
Norfolk
Norwich
Peterborough
Shropshire
Leicestershire
West Midlands
Huntingdonshire
Powys
Warwickshire
Northamptonshire
Cambridgeshire
Suffolk
Hereford and Worcester
Bedfordshire
Ipswich
Dyfed
Oxford
Buckinghamshire
Hertfordshire
Essex
Gloucestershire
West Glamorgan
Gwent
Mid Glamorgan
Oxfordshire
Chelmsford
London
Berkshire
South Glamorgan
Avon
Reading
Wiltshire
Bristol
Surrey
Hampshire
Dover
Somerset
Kent
Southampton
West Sussex
East Sussex
Dorset
Devon
Isle of Wight
Cornwall
Plymouth

Pupil premium

https://www.gov.uk/guidance/pupil-premium-information-for-schools-and-alternative-provision-settings

- Pupil Premium is additional funding for publicly funded schools in England to raise the attainment of disadvantaged pupils of all abilities and to close the gaps between them and their peers
- national average for all maintained schools is currently 27.8%

Chemistry for all research: UCL IOE

Michael Reiss, Tamjid Mujtaba, Richard Sheldrake

- Does an intervention programme increase participation in chemistry post-16 ?
- To what extent do effective interventions have differential effects on particular student groups (e.g. by ethnicity, gender, socio-economic status)?
- How, if at all, do these interventions depend on teacher and school characteristics and on the ages of students?
- Longitudinal study including student surveys, teacher and student interviews, observations of interventions.

Liverpool John Moores University

- www.ljmu.chemistryforall.co.uk

School	Local Authority	Gender	Age Range	% Pupil Premium	% 5+ A*-C Grades 2015 (E/M)	OfSTED Grading
a	Knowsley	Mixed	11-18	62.5	40.3	Requires Improvement
b	Wirral	Mixed	11-18	51	30.4	Inadequate (April 2016)
c	Liverpool	Mixed	11-18	69	42.0	Requires Improvement (May 2016)
d	St Helens	Mixed	11-18	50.0	49.0	Good (Dec 2011)
e	Liverpool	Male	11-18	43	50.0	Requires Improvement (Jan 2015)
f	Wirral	Mixed	11-16	43.4	60.0	Good (May 2016)

Chemistry for all: Liverpool John Moores interventions in school and out of school

- Drama events
- STEM ambassador visits
- Working Scientifically
- Chemistry in Your Shopping Basket (CIYSB) - combines student activities and teacher demonstrations.
- Chemistry in Careers Activity
- Chemistry of Large Molecules

LJMU Drama events

- performed by university drama students
- emphasise the importance of Chemistry in everyday life and attempt to show students that knowledge of Chemistry is important to a range of occupations
- delivers a positive message that taking an interest in studying in Chemistry will be beneficial in life
- A play lasts about 15 minutes and features songs and jokes to entertain and engage students

LJMU STEM ambassador visits

- University student advocates talk to students about what has inspired them to study science.
- These students are closer in age to the school students, from similar backgrounds, and they have been well-received.

LJMU Working scientifically

- For example, an introduction to kinetics and how the rates of reaction can be measured.
- The session began with a demonstration of “turning wine into water” – this was a “WOW!” moment with many students asking how it worked. After discussion of what is meant by a chemical reaction, the students investigated how the rate of reaction can be altered by *temperature* by observing Glo-sticks in hot and cold water, s*urface area* by watching a demonstration of a custard powder bomb, and *concentration* using the iodine clock experiment.

LJMU Working Scientifically

- The event was a mixture of “attention grabbing” demonstrations and practical work designed to give the students a chance to question, investigate and draw conclusions based on key scientific ideas.
- Whilst performing the iodine clock, one of the students was overheard saying, “This is so cool”!


TiPToP

Chemistry in Your Shopping Basket (CIYSB)

- King Kong's hand experiment in which vinegar is reacted with NaHCO3 to release CO2 which was contained within a disposable glove.
- The nappy demonstration in which the hydrogel polymer used in disposable nappies was placed in a cup and water added. The upturned cup showed that the water had been absorbed. This led into a discussion of hydrogels as fire proofing.

LJMU Chemistry in Careers Activity

- Links to short videos were provided for students to discuss.
- The videos covered a range of careers including sports scientist, flavour chemist, patent lawyer and drug discovery chemist.
- The variety of scientist profiles included men and women of different ages, with different entry level qualifications and of different ethnic groupings.

LJMU Chemistry of Large Molecules

- Additional polymerisation
- After this activity, most students were able to identify a monomer in a polymer chain and use the white boards to draw a polymer from a given monomer and vice versa.
- Making slime using PVA glue and Borax.

LJMU event out of school

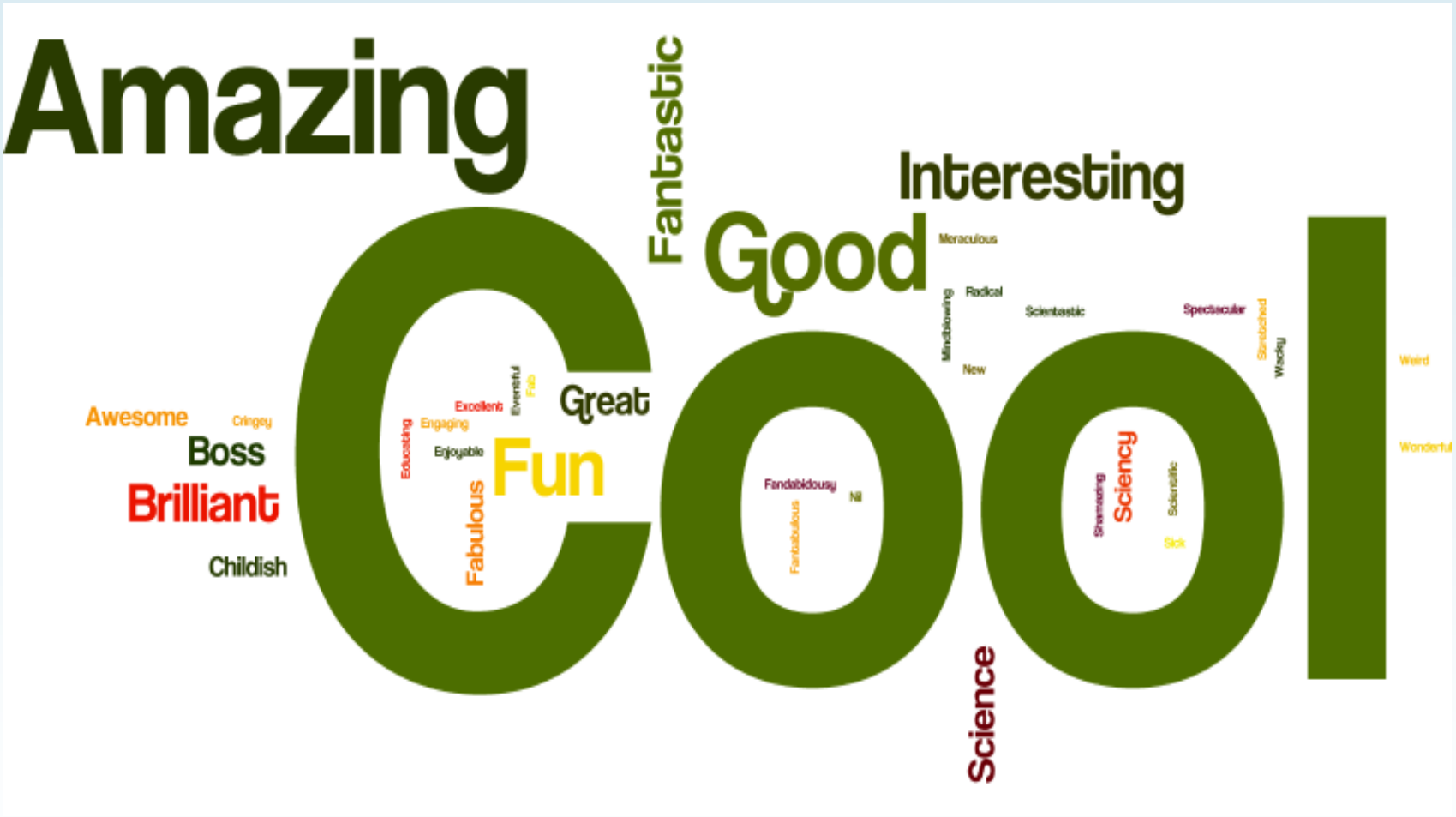
- **Chemistry in Your Life** (CIYL)
- making an ointment and investigating emulsions.
- These experiments required calculations by the students, weighing of materials, safe use of Bunsen burners, the use of a microscope, handling hot equipment and observation.

LJMU out of school event: Chemistry at the Crime Scene

- Forensic Science staff at LJMU supported by laboratory technicians, university student interns, students advocates and also students from the Forensic Science programme.
- The procedures included white powder analysis, fingerprint analysis, tool cast analysis, hair and fibre analysis, flame testing and analysis of blood samples.

LJMU evaluation

- 73% of the learners expressed the top level of enjoyment.
- 37% of pupils thought they learned a lot and 85% learned something or a lot.
- As the cohort moved into Year 9 (age 13-14) from Year 8 (age 12-13) the responses to the questions about enjoying and learning something from the activities remained overwhelmingly positive.


Amazing
Fantastic
Interesting
Good
Meraculous
Radical
Scientastic
Spectacular
Mindblowing
Stonkered
Wacky
New
Weird
Wonderful
Awesome
Cringey
Boss
Brilliant
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Interesting
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Flabbergasting
Enjoyable
Intriguing
Flabitastic
Jimmy
Enlightening
Chemistry
Fab
Factual
MLG
Cool
Super
Flammable
interesting
Physics
Exciting
Yay

Communications with Key Stakeholders during the Project

- Students
- Teachers/professional developers
- Parents/carers
- School leaders
- School governors

UCL IOE research

- Survey, once a year for 5 years
- Student interviews
- Teacher interviews
- Observations

Chemistry for all survey

- The role of science in your life
- Your future plans involving science and chemistry
- Science in your current school
- Your science lessons and views of science
- Your science teacher
- Your views about what those with science qualifications do
- How you feel about your science attainment and effort
- How you feel about yourself in school
- Thinking about the encouragement and support you receive in science
- Your views on the relevance of science

Student interviews

- Do you think science is important?
- Do you like science at school?
- What sort of things do you do in science?
- How do you get on in science?
- Do you find science easy/difficult?
- Do you think science will be a useful subject for you in the future?
- What do you do to succeed in science?
- Does anyone in your family take an interest in science?
- Do you ever ‘do’ science or find out about it outside of school?
- Will you carry on doing science when you have to choose? Would you be interested in working in science?

Project 2: MultiCo

- Promoting Youth Career Awareness and Attractiveness through Multi-stakeholder Co-operation: Funded by European Union call Horizon 2020
- Based on the premise that Europe needs more scientists to solve the major challenges related to energy, water, waste, climate change, food, health and transport issues, as well as scientifically literate citizens as decision-makers and social actors.

Aim of MultiCo

- To attract more students towards studying science by focusing on making school science more relevant and exciting for students, as well as raising awareness of the multitude of science-related careers and the motivation of students to pursue such careers.
- MultiCo includes partners working together from five countries: UK, Finland, Estonia, Germany and Cyprus.

MultiCo approach

- To introduce students to science and technology related research and innovative developments, using real life career-focused scenarios.
- To initiate context- and inquiry-based science studies to enhance skills such as collaboration, creativity and reasoning.
- To take into account students' own ideas to enhance the relevance of science studies.

MultiCo research

- Focuses on producing evidence of the impact of a career-based science education on students' science study choices, career awareness and attitudes towards science-related careers.
- Aims to produce tangible outcomes for use by researchers, teachers, teacher educators as well as policy-makers for educational planning.

MultiCo framework

- Previous research - on motivation, interest, science activities, career counselling and subject choice.
- Pre and post questionnaire - to determine student factors and evaluate impact.
- Stakeholders and students create career-based scenarios - to be included in science teaching.
- Interventions - to study the implementation and outcomes of scenario-based teaching.

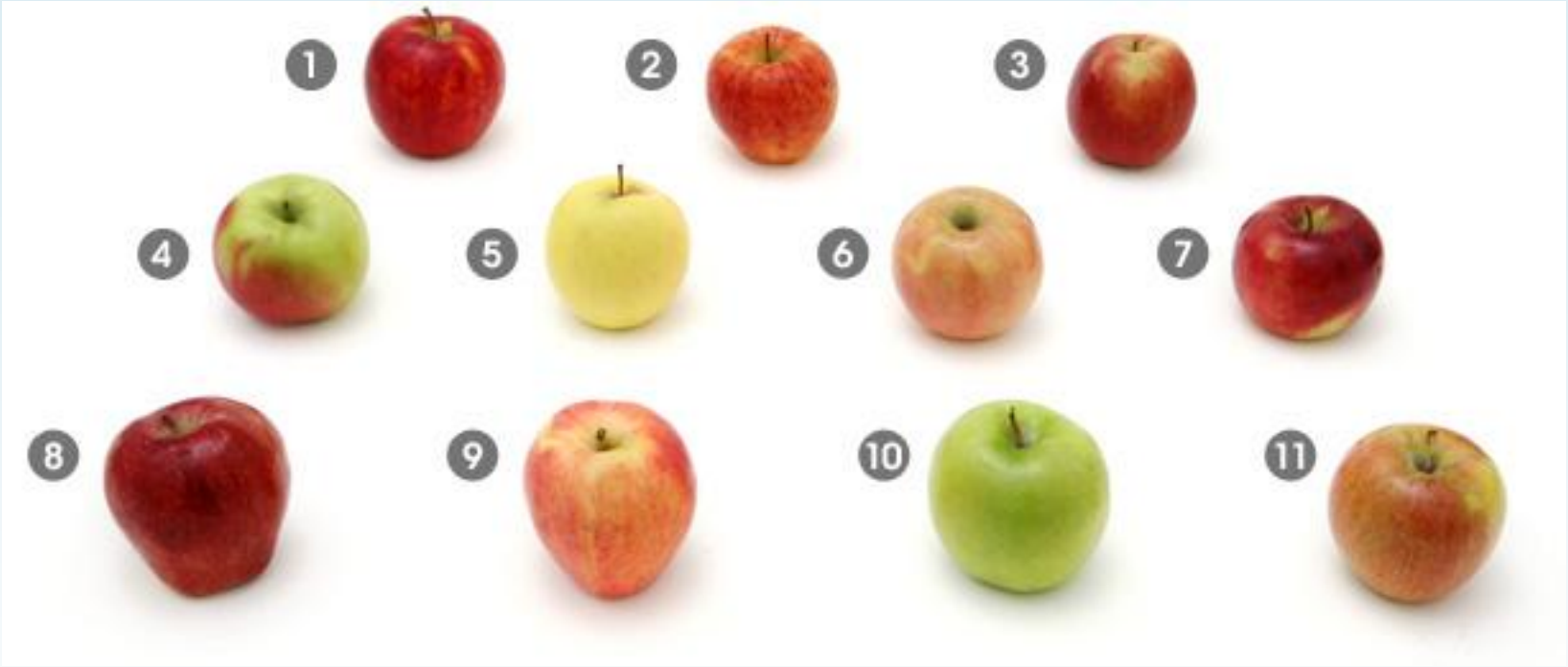
UK MultiCo team

- **Inês Direito**
- **John Connolly**
- **Jillian Trevethan**
- **Joanne Nicholl**

A little competition:

Who can name the biggest number of apple varieties?

Find the right names



Braeburn
Cameo
Cortland

Empire
Fuji
Gala
Golden Delicious

Granny Smith
Jonagold
McIntosh
Red Delicious

Well done!
Most people do not know about all these varieties.

My name is Charlotte Lusty.
I work for the Crop Trust.

CROP TRUST

Any idea what this might be?

CROP TRUST

Seed vault at the arctic Islands of Svalb

The Crop Trust coordinates all gene banks in the world, which store the varieties of all important crops, e.g. rize, wheat, maize, beans, potatoes, bananas, etc.
The most important gene bank is the „Seed Vault“ in Svalbard (NOR), which is constructed like Fort Knox: the seeds are protected against natural disasters, climate

Short video clip

- Too large to insert in this version for email

But why is it so important to safeguard crop diversity?

Inquiry (Science learning) & Consolidation:

Biology:
-**Learning content:** diversity of organisms as a resource; organisms and habitats; agriculture: pests, fertilisers, herbicides & pesticides (future challenges: food, climate change, health, biodiversity)
-**Methods:**
e.g.:
➢Checking the crop diversity (e.g. apples, rice, potatoes) in a nearby supermarket and comparing the results to national or global databases of cultivated varieties available in a country or in the world;
➢Collecting information on pests and pest control, effects of monoculture, use of fertilisers and herbicides & pesticides, global threats to agriculture and discuss the value of crop diversity in relation to these challenges;
➢Testing the taste/smell/consistency of different varieties of a crop species (e.g. apples) and discussing the different aspects of biodiversity

Pre-questionnaire data analysis

- **Participants**
- A total of 210 questionnaires were analysed by UCL.
- 120 were girls (57.1%), and 90 were boys (42.9%).
- The age range was 13-14 years old (Mean age = 13.7).

Student interest

- Overall, the most preferred topics in science are Biology and Chemistry;
- Girls are more likely to prefer Biology
- Boys are more likely to prefer Physics
- Overall, of the science topics related to the European 7 challenges, Health and Ecology are the ones students like more (the other topics are: Food, Energy, Technology, Transport and Ethics in science);
- Girls' interest in Health topics is higher than for boys.

Science relevance/value

- Students are more likely to agree with the following statements: *Science is important for helping us to understand the natural world; Advances in science and technology usually improve people's living conditions; Science is valuable to society.*
- Students are less likely to agree with: *Science is very relevant to me; I will use science in many ways when I am an adult; When I leave school there will be many opportunities for me to use science*
- Almost half of the students strongly agree that science is important and valuable to society, but only one in four strongly agrees that science is personally relevant to them.

Science experiences

- The most popular are: *taking nature photos*, *visiting web sites about science topics*, and *watching TV programmes about science*.
- The least popular are: *listening to radio programmes about advances in science*, *attending a science club/camp*, and *reading science magazines or science articles in newspapers*.

Self-perceptions

- Girls have a significantly lower self-perception regarding science subjects when compared with boys in all of the following statements:
  - *Compared to others of my age I am good at science classes*
  - *I get good marks in science*
  - *Work in science classes is easy for me*
  - *I learn things quickly in science classes*
  - *I have always done well in science*

Career intentions

- Girls' most preferred career areas are in Health and Medicine (34.5%), Creative Work (31.9%), Social Work (27.7%), Economy (26.1%) and Technology (23.5%)

- Boys' most preferred career areas are in Technology (57.8%), Economy (34.4%), Creative Work (26.7%), and Health and Medicine (23.3%).

Aspirations

- The top three career aspirations are *I want to make use of my talent/abilities*, *I want to make money*, and *I want to work in an area with lots of job opportunities*;
- The least important are *I want to become famous*, *I want an easy job*, and *I want to be a supervisor/leader;*
- *I want to make money*, *I want to be a supervisor/leader*, and *I want to invent new things* are more important for boys than for girls;
- *I want to help other people* is more important for girls than for boys.

Conclusions so far

- The interventions – how do these address the underlying factors that influence student choice. What assumptions are made about these interventions?
- Research approaches and measures – are these valid measures of impact?
- How can educators influence student choice?