You can’t know what you’re missing if you don’t know what you need:

A new model of skill requirements and skill mismatch

Jim Allen
Research Centre for Education and the Labour Market
Maastricht University, The Netherlands
THE RIGHT STUFF
What skills did the first astronauts need?

- Prior to their recruitment, the Mercury astronauts were highly skilled military test pilots:
  - Solid understanding of aeronautics
  - excellent feel for aircraft
  - finely honed motor-skills and reaction speed
  - rapid diagnostic and problem-solving skills
  - ability to perform under pressure
  - effective communication skills
  - etc.

- Were those the skills the first astronauts needed?
- Hint: consider some of the other potential candidates
Testosterone
What does this tell us about skill mismatch?

• A few simple lessons:
  - Skills aren’t always used even when they are abundantly present
  - From NASA’s point of view, “The Right Stuff” was a limited subset of the astronauts’ “skills”
  - From the astronauts’ point of view, “The Right Stuff” is quite different: most of their skills were severely underutilized
  - Both sides are important when considering mismatches:
    - When workers lack the required skills, productivity can suffer, and firms can have trouble meeting orders etc.
    - When a substantial part of workers’ skills are not utilized, potential productivity can also be lost, leading to lower wages, job satisfaction, work commitment, etc.
What follows

• Overview of existing models
• Reflection on the nature of jobs, skill requirements and mismatches
• “The Right Stuff” model
• Relation with antecedents
• Relation with outcomes
• Comparison with other models
• Conclusions
Existing skill mismatch measures

- Flisi et al, 2017 give a useful overview of mismatch measures developed to date:
  - **Self-assessed**: subjective self-rating of the extent to which skills possessed are adequate and/or required in work (Halaby 1994, Allen & van der Velden 2001, Mavromaras et al. 2007, Green & McIntosh 2007, Vieira & Cabral 2005)
  - **Realized matches**: mismatches defined as a deviation by a certain value (usually 1 or 2 standard deviations) from mean or mode skill per occupation; borrowed from educational mismatch tradition (Verdugo and Verdugo 1989)
  - **Skills in relation to engagement**: individual’s skill level and self-reported engagement in skill-related tasks at work divided into low, medium and high engagement; mismatch defined as workers “off the diagonal” (Krahn and Lowe 1998; Desjardins and Rubenson 2011)
  - **Skills in relation to use**: difference between standardized skill level and skill use identifies individuals using their skills to a higher or lower degree than one would expect based on their skill level (Allen et al. 2013)
  - **Mix of subjective and objective data**: workers whose proficiency score lies outside the observed range among workers in the same occupation and country who report being neither over- nor (Pellizzari and Fichen 2013)
An intuitive look at skills, job tasks and mismatches

Worker
= bundle of skills
Skills, job tasks and mismatches

**Worker**
= bundle of skills

**Job**
= bundle of tasks assigned by firm
Skills, job tasks and mismatches
Skills, job tasks and mismatches
Skills, job tasks and mismatches
Skills, job tasks and mismatches
Skills, job tasks and mismatches

PERFECT MATCH!
Skills are not set in stone ....

Skills can be adjusted to better match the job (e.g. training, learning by doing)
Skills are not set in stone ....

Skills can be adjusted to better match the job (e.g. training, learning by doing)
Skills are not set in stone ....

Skills can be adjusted to better match the job (e.g. training, learning by doing)
... but neither are skill requirements

The job can also be adjusted to better match skills (e.g. by changing task assignments)
... but neither are skill requirements

The job can also be adjusted to better match skills (e.g. by changing task assignments)
... but neither are skill requirements

The job can also be adjusted to better match skills (e.g. by changing task assignments)
Demand may also adjust to aggregate supply

Sometimes skill requirements for a whole class of jobs (e.g. countries, regions, occupations, economic sectors) adjusts to reflect the available skill supply.
Demand may also adjust to aggregate supply

Sometimes skill requirements for a whole class of jobs (e.g. countries, regions, occupations, economic sectors) adjusts to reflect the available skill supply
.... and demand adjusts to aggregate supply

Sometimes skill requirements for a whole class of jobs (e.g. countries, regions, occupations, economic sectors) adjusts to reflect the available skill supply
How do we measure demand in practice?
How do we measure demand in practice?

This usually comes down to looking at the existing skill distribution (within an occupation, for given levels of skill use, etc.)
But demand is heterogeneous too
But demand is heterogeneous too
But demand is heterogeneous too
This is the real match
This is the real match
This is the real match
This is the real match
This is the real match
This is the real match
The trick: match workers to their actual job ...
... rather than to a broad, heterogeneous class of jobs
The model in a nutshell

• Full disclosure: I don’t claim to fully solve the problem of heterogeneous skill requirements
• I do claim to offer a better approximation than existing models
The model in a nutshell

• The short version:
  - A “skill fingerprint” is constructed for each worker in the respective domain under consideration
  - This comprises a robust estimate per reading or numeracy task of the expected skill level for workers in the same country X occupation combination, performing the same task at the same frequency as the worker concerned
  - Those reporting that they never perform a given task are assigned a skill level for that task equal to 1.5 standard deviations below the mean in the country-occupation combination to which they belong
  - The required skill level is derived as the mean of the “most difficult” tasks in a given domain (literacy or numeracy) according to this metric
  - Workers are more or less underskilled or overskilled depending on how much they deviate from the required level
The model in a nutshell

• The specific “skill fingerprint” of a worker makes a lot of difference for estimated skill requirements, much more than simply considering skill use as a whole, without reference to the specific tasks involved.

• Because the number of task-frequency combinations within an occupation is very large, this models incorporates a much greater variation in skill requirements within countries and occupations than existing models.
Relation with antecedents

• Multivariate models estimating effects of a range of covariates on the chance of being well-matched, underskilled or overskilled:
  - Personal/background characteristics: gender, age, migration background, native language, parental education, books in childhood home
  - Job characteristics: occupation, organization size, tenure, working hours, economic sector, (self-)employment, type of contract, participation in training, index of learning at work, index of task discretion
  - Actual and required education: years of education, years of over/undereducation, currently in education
  - Country dummies
Relation with antecedents: gender

![Bar chart showing the effect of gender on literacy and numeracy levels, with female performance compared to male performance. The chart indicates that female performance is generally higher in numeracy and lower in literacy relative to male performance.](chart.png)
Relation with antecedents: gender

![Bar chart showing effect of gender (female vs male) in literacy and numeracy.](image-url)
Relation with antecedents: age
Relation with antecedents: age

- literacy
- numeracy

Graph showing the effect of age on literacy and numeracy.
Relation with antecedents: migration background

![Bar chart showing the effect of migration background on literacy and numeracy for first and second generation immigrants.](chart.png)
Relation with antecedents: migration background

![Bar chart showing the effect of migration background and language on literacy and numeracy for 1st and 2nd generation immigrants.](chart.png)
Relation with antecedents: education-job match

![Graph showing the effect of education-job match on literacy and numeracy levels.](image-url)
Relation with antecedents: education-job match
Relation with antecedents: job tenure
Relation with antecedents: job tenure
Relation with antecedents: job-related training

The diagram illustrates the effect of job-related training on literacy and numeracy for the underskilled and overskilled categories. The bars indicate a decrease in literacy and numeracy for the underskilled category and an increase in literacy for the overskilled category.
Relation with antecedents: job-related training

![Effect of job-related training](image)

- Literacy: 3%
- Numeracy: 1%
Relation with antecedents: informal learning
Relation with antecedents: informal learning

![Graph showing the effect of learning at work compared to literacy and numeracy levels.](image)
Relation with antecedents: task discretion
Relation with antecedents: task discretion
Relation with outcomes

- Multivariate estimates of effects of mismatch on ln(hourly earnings), perceived need for more training, and job satisfaction, controlled for range of covariates:
  - Skill proficiency scores (literacy and numeracy)
  - Personal/background characteristics: gender, age, migration background, parental education, books in childhood home
  - Job characteristics: occupation, organization size, tenure, working hours, economic sector, (self-)employment, type of contract, index of learning at work, index of task discretion
  - Actual and required education: years of education, years of over/undereducation, currently in education
  - Country dummies
Relation with outcomes: earnings
Relation with outcomes: needs more training

![Graph showing the relation between literacy and numeracy and needs for training.](image)
Relation with outcomes: job satisfaction
Comparison with other models

• So far only conducted for literacy mismatches
• Compare new measure with Allen et al 2013 and a simple realized matches model
• Many results very similar, in sign if not always in magnitude of effect (age, migration background, job tenure)
• Only results with clearly contrasting effects shown
Comparison other models: effect of gender

![Bar chart showing the effect of gender (female vs male) for different models: "The Right Stuff" model, RM model, Allen et al. model, underskilled, "The Right Stuff" model, RM model, Allen et al. model, overskilled.](image-url)
Comparison other models: effect of gender
Comparison other models: education-job match
Comparison other models: education-job match

![Graph showing the effect of education match for different models. The x-axis represents undereducated to overeducated, and the y-axis shows the overskilled effect. The graph compares "The Right Stuff" model, RM model, and Allen et al model.](image-url)
Comparison other models: education-job match
Comparison other models: job-related training

effect of job-related training

"The Right Stuff" model
RM model
Allen et al. model
underskilled
overskilled

Maastricht University
ROA
Comparison other models: job-related training
Comparison other models: informal learning

![Graph showing the effect of learning at work for different models. The x-axis represents learning levels (lw0 to lw4), and the y-axis represents the underskilled metric. The lines represent different models: "The Right Stuff" model, RM model, and Allen et al model. The graph illustrates the relative performance of these models across various learning stages.]
Comparison other models: informal learning
Comparison other models: informal learning
Comparison other models: task discretion

![Graph showing the effect of task discretion for different models. The x-axis represents task discretion levels (td1 to td5), and the y-axis represents underskilled. The graph compares "The Right Stuff" model, RM model, and Allen et al model. Different lines indicate the effect of task discretion on underskilled levels.](image)
Comparison other models: task discretion

![Graph showing the effect of task discretion for different models](image-url)
Comparison other models: task discrepancy
Comparison other models: need more training
Comparison other models: job satisfaction
Conclusions

• If you want to measure mismatches, you have to get as close as possible to what skills are really required
• Existing models brush over this issue much too quickly risk of flawed policy conclusions
• By taking account of workers “skill fingerprint” – the skills observed among workers performing the same tasks with the same frequency in the same occupations and countries – we can obtain a much closer approximation of the skills the worker is required to possess
Conclusions

• In terms of antecedents, mismatches are related to, among other things, overeducation (but not to undereducation), age and job tenure, informal learning and job-related training
• In terms of outcomes, mismatches are strongly predictive of earnings and perceived training needs, but only weakly and inconsistently to job satisfaction
• The model performs similarly to other models in most respects, but some marked differences
Conclusions

• The model is still very much work in progress; there is almost certainly room for improvement → suggestions welcome!

Thank you for your attention!

Contact me at j.allen@maastrichtuniversity.nl