The Concept of Skills Mismatch and the Problem of Measuring Cognitive Skills Mismatch in Cross-National Studies

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Abstract. Skills mismatch implies discrepancy between the skills of job candidates or employed workers and job requirements. Types of mismatch are identified based on three criteria: quality of mismatch (surplus vs. shortage), reporting party (employer vs. worker/candidate), and type of skills (cognitive vs. technical). Differences in types of skills mismatch account for considerable variation in qualitative interpretation and quantitative measurement. The problem of skills mismatch has been widely debated across the OECD countries, yet it remains understudied in Russian research literature. The issue raises concerns among education and labor market researchers as well as practitioners, so this article analyzes the available findings from the prospective of their potential use by educational institutions being the key consumers of data on skills mismatch and the ones that should tackle the problem.
Five types of skills mismatch are identified, along with the specific challenges of measurement and interpretation. The article describes three methods of skills mismatch measurement to be selected as a function of which type of skills supply and demand data is used: indirect, objective direct, and subjective direct measurement. It also classifies methods of measuring the cognitive skills gap in the major cross-national studies: PIAAC, STEP, and OECD Skills for Jobs Database. It transpires that cross-national comparisons of cognitive skills mismatch mostly have to use a mixed approach due to limitations typical of cross-country research, such as the lack of objective data on skills demand and relying on subjective or indirect data alone. For this reason, the results of most cross-national skills mismatch assessments cannot be implemented by educational institutions.
Keywords: cognitive skills, skills mismatch, education, labor market, employer's requirements, cross-national comparisons.

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It was in the 2000s-2010s that researchers began to focus on the development of skills, especially cognitive ones. A proven predictor of professional success [Hanushek et al. 2015; Pellizzari, Fichen 2013], cognitive skills are one of the most important prerequisites for build-

ing a successful career trajectory at a time when the global labor market is undergoing radical transformations and the days of staying in one job, or with one company, for decades are waning [World Bank 2019]. In this context, the problem of skills mismatch has become one of the most hot-button issues at both national and international levels.

The earliest studies on skills mismatch date back to the 1970s-1980s, when levels of workers' educational attainment skyrocketed in high-income countries. The pioneering work of Richard B. Freeman [Freeman 1976] introduced the concept of overeducation in the scientific discourse, setting the stage for ample research into the problem of gaps between manpower qualifications and labor market requirements. Further on, the problem of skills mismatch (in the form of overeducation for the most part) began to be approached from the perspective of its influence on the labor market [Allen, van der Velden 2001; Sicherman 1991; Bauer 2002] and human capital development [Mendes de Oliveria, Santos, Kiker 2000]. It has been proved, by the example of overeducaiton, that skills mismatch is associated with tremendous costs at both macro- and microeconomic levels, affecting negatively aggregate labor productivity and technological progress as well as employee earnings and job satisfaction [McGowan, Andrews 2015; McGuiness, Pouliakas, Redmond 2017].

Initially, the problem of skills mismatch was approached as an imbalance between aggregate supply and demand, a problem of matching jobs with qualifications (i. e. education) [Jovanovic 1979, Sattinger 1993]. It was only in the late 2000s and particularly in the 2010s that a micro notion of skills mismatch came to be distinguished, defining the phenomenon as discrepancy between the skills possessed by a worker and those required to perform a job—at the level of each single worker-job pair [Pellizzari, Fichen 2017:3]. The issue made it to the academic and political agenda following a series of business surveys that revealed low employer satisfaction with worker skills, this shortage of human capital being ranked among the top impediments hindering business growth[1]. At the same time, the first results of international surveys of cognitive skills, including the ones involving adults (PIAAC), made it possible to measure specific-skill mismatches.

In the 1920s, the focus of research shifted to empirical measurement of the gap between the specific skills possessed by workers and those required by employers [OECD2013b; Perry, Wiederhold, Ackermann-Piek 2014; OECD2015; McGuinness, Pouliakas, Redmond 2017]. As a result, the problem of skill shortage was unveiled and brought into the spotlight. Remarkably, the shortage of cognitive skills has been associated more often with the quality of formal edu-

[1] This provoked a fierce debate over the problem of skill gaps in the sociopolitical arena. While some believe the concerns are overblown (e. g. [Krugman 2014; Weaver 2017]), others have no doubts that the skill gap is real [Bessen 2014].

cation, while that of technical skills might be a product of poor candidate awareness and recruitment mistakes [OECD2013b]. For instance, colleges are often blamed for offering programs focused on technical skills and paying little attention to generic competencies [ACT 2011; World Bank 2015].

There are two prominent talking points in the plot-twisting debate on skills mismatch. First, mismatch can take various forms, which entails a considerable variation in qualitative interpretations and quantitative measurements. Second, there is no agreement among researchers or practitioners on how the discrepancy between skills supply and demand should be measured, so no unequivocal mismatch measurements exist so far. As a result, the purely academic problem of choosing the optimal methodology for measuring skills mismatch spirals into a real-life concern for educational institutions as consumers of skills mismatch data and the ones that seek to reduce the gap. In other words, how treatment can be started if there is no exact diagnosis?

This article attempts to answer the following questions:

1. What are the forms that skills mismatch can take, and what are the measurement and interpretation challenges that arise from this diversity?
2. What are the approaches that cross-national assessments use to measure skills mismatch manifestations?
3. What are the limitations of the existing assessment methods and their outcomes? Can educational institutions implement the results of cross-national surveys of cognitive skills in practice?

The article consists of three sections. The first one examines the types of skills mismatch and describes their qualitative interpretations. The second one presents a typology of methods to assess the mismatch between workers' cognitive skills and employer requirements. The assessment methods used in PIAAC, STEP, and Skills for Jobs are compared, along with the associated limitations. The final part of the article discusses the opportunities and limitations of implementing the skills mismatch data obtained with different assessment methods.

1. The Concept and the Problem Field of Skills Mismatch

1.1. Types of skills mismatch

The term *skills mismatch* is common to find in economic literature as well as national and global strategies for labor markets and education. The generalized term implies discrepancy between the skills possessed by workers and the requirements of jobs [Handel 2003], both at the level of proficiency and the type of skill. Researchers distinguish between short-run and long-run skills mismatches (Table 1). Michael Sattinger [Sattinger 2012] defines a short-run skills mismatch as a current gap in the level or set of skills caused by candidates being imperfectly matched to vacancies, attributing such gaps to ineffective policies of labor institutions while holding the formal education sys-

Table 1. **Characteristics of Short- and Long-Run Skills Mismatches** [Sattinger 2012:6]

Characteristic	Short-run	Long-run
Causes	Low candidate awareness and recruitment mistakes	Unbalanced changes in supply and demand due to major shifts (in technology, institutional landscape, etc.)
Measures	Differences in individual job and worker characteristics	Assessments and forecasts of aggregate differences in supply and demand in the labor market
Consequences	Costly search for workers and firms, losses in worker wages, and lower firm output	Lost returns to worker investments in education and training, inadequate labor force for firm expansion and growth
Policies that address mismatches	Labor institutions to reduce search costs	Adapt educational policies to anticipated changes in the labor market

tem responsible for long-run mismatches. However, education flaws can lead to short-run mismatches as well, especially when it comes to general competencies. On the whole, both perspectives on the reasons for mismatch (imperfect recruiting decisions and low employer engagement in workforce development, on the one hand, and formal education flaws, on the other) are valid and not exclusive of each other.

The problem is pervasive and has a variety of manifestations, which often go undifferentiated under the umbrella term of *skills mismatch*. In practice, it may denote skill shortage, skill obsolescence, or field-of-study mismatch—all of which have different causes and require different measurement approaches.

Below, the major types of mismatch are analyzed. Three criteria—quality of mismatch (surplus vs. shortage), reporting party (employer vs. worker/candidate), and type of skills (cognitive vs. technical)—yield eight types of mismatch (Table 2). Three of them are not exactly skills mismatches but rather qualifications/education mismatches (shaded in grey in Table 2): overeducation, undereducation, and horizontal/field-of-study mismatch. Although education data is often used as proxy variables in assessing the level of skills, low reliability of such proxies has led to discrimination between qualifications/education mismatch and skills mismatch in the most recent studies. Results of the 2014 European Skills and Jobs Survey provide evidence that the level of education cannot be equaled to that of skills. In particular, it reveals that 19% of higher-educated workers who were found to be overeducated simultaneously lacked the skills their job needed

Table 2. **Types of Mismatch**

Surplus	Reporting party	Type of skill	Shortage	Reporting party	Type of skill
Overeducation	Worker	CS TS	Undereducation	Worker	CS TS
Overskilling	Worker	CS TS	Underskilling	Worker	CS TS
Horizontal / field-of-study mismatch	Worker	TS	Skill gap	Employer	CS TS
Skill obsolescence	Employer	TS	Skill shortage	Employer	TS

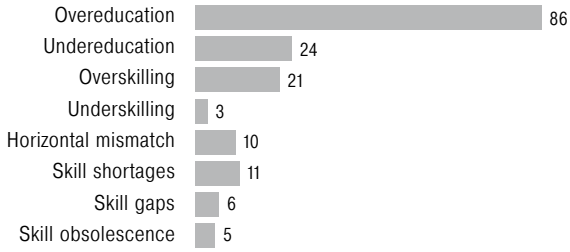
Note: CS—cognitive skills; TS—technical (job-specific) skills.
Source: Adapted from [McGuinness, Pouliakas, Redmond 2017].

when hired, which means that overeducation does not necessarily imply overskilling [Cedefop 2018a:51].

As shown in Table 2, skill shortage has a number of manifestations (underskilling, skill gap, skill shortage), which can be reported by both parties involved, employer and worker. Skill gap and underskilling are used interchangeably by a lot of researchers (e.g. [Quintini 2011]). These types of shortage are both measured by surveys, skill gap among employers, and underskilling among workers. However, empirical evidence indicates that the relationship between skill gap and underskilling measurements is not that obvious. For instance, [McGuinness, Ortiz 2016] compared data on skills mismatch within Irish firms based on a linked employer-employee survey. It turned out that employees reported skill imbalances much more often than their employers. As a result, the prevalence of underskilling was much higher than that of skill gaps. The greatest discrepancy between employers' and workers' perceptions of skills mismatch was observed for the fundamental cognitive skills of literacy and basic numeracy (agreement of only 33%). Several hypotheses have been proposed to explain this asymmetry, the central one being that employees were more biased in their perceptions as they assessed their matching to prospective requirements rather than current ones.

Skill gap and skill shortage are the key mismatches reported by employers, and it is vital to understand the difference between the two. Skill gap implies an insufficient level of proficiency in the workplace, which pushes employers to organize on-the-job training. Skill shortages create even a more severe problem, reducing job filling rates due to the lack of adequately qualified candidates. However, the negative effects of skill gaps ultimately turn out to be more extensive, as the problem is usually solved by hiring relatively suitable candidates who

Figure 1. **Number of Skills Mismatch Papers Published in 2006–2016, by Type of Mismatch**
[McGuinness, Pouliakas, Redmond 2017: 9]



Note: The review involved articles published in international peer-reviewed journals, publications of the World Bank, OECD, Cedefop, and Institute of Labor Economics. Because papers on skill gaps, skill shortages, and skill obsolescence are very few, publications published before 2006 were also included in analysis.

have to be trained in the workplace. Therefore, skill shortages can entail manifestations of skill gaps. Another difference is that skill shortage implies the lack of job-specific skills (in highly- as well as medium-qualified jobs), whereas gaps are reported by employers across all types of skills.

A review of literature on skills mismatch published since the mid-2000s shows that half of the publications address the problem of overeducation, paying far less attention to skill deficit (38% in 2006–2016; 12% only, if undereducation is left out) [McGuinness, Pouliakas, Redmond 2017] (Figure 1). Meanwhile, national policies of the world's top economies have been traditionally focused on solving the problems of skill gap and skill shortage, even though the evidence is insufficient yet to recommend this strategy.

A few hypotheses may be suggested to explain the difference in the focus of national policies and research efforts. Authorities' concerns about skill shortages are fueled by the needs of businesses that incur considerable expenses. Underskilling and skill shortages have a direct negative impact on labor productivity, affecting the size of investments in workforce training and development[2]. The reason for researchers mainly elaborating the problem of overeducation may be the high incidence of this phenomenon in the top OECD countries from which the publications originate. Indeed, population with tertiary education in the group of 25–34 year-olds exceeds 40% in 26 out of 35 OECD countries [OECD2018a].

[2] For example, 20% of establishments surveyed in Great Britain claimed that skill gaps had delayed the introduction of new products, and nearly one in three claimed that the gaps caused difficulties with the introduction of new working practices [Tether et al. 2005].

Table 3. **Cross-Classification of Workers by Personal and Job-Required Skills** [Handel 2017]

Supply (level of personal skills)	Demand (level of job-required skills)		
	Low	Medium	High
Low	1	2	3
Medium	4	5	6
High	7	8	9

(1)—low-skill match
(5)—medium-skill match
(9)—high-skill match
(2, 3, 6)—underskilling and skill gap
(4, 7, 8)—overskilling and skill gap

1.2. "Healthy" skills mismatches

Skills mismatch can take a variety of forms, but is *match* always the sought-for optimum? Skills match is measured as the degree to which the level of worker skills is matched to the one required by employer. A simplified framework for understanding the match-mismatch paradigm is proposed by Michael J. Handel [Handel 2017] (Table 3). It highlights areas of mismatch with skill surpluses and shortages as well as a few match situations for low, medium, and high levels of skills required by jobs. The low-skill match, however, is not regarded as an inherently positive situation but rather as formal absence of skills mismatch in low-skill occupations. More than that, some experts argue that the goal of perfect skills matching is a chimera and that one-shot policy measures are likely to be short-lived [Cedefop 2018a:15].

There has been much debate over the rationality of pursuing the goal of perfect skills matching and preventing skills mismatches. The prevailing opinion dictated by the demand side—employers—is that skills are largely in deficit. With graduates being underqualified, employers experience difficulties finding workers with required skills or adequate skill levels. The alarmist skills gaps narrative makes it easy to surrender to the idea of fighting the gap unconditionally and bringing the supply and demand to a perfect balance. However, a number of researchers (Table 4) consider evidence of skill gaps insufficient, as the majority of population has their skills unrecognized or underutilized—which means that the deficit, even if real, is largely determined by low incidence of workplace learning and stagnant task variety in some sectors.

Cedefop experts believe that levels of skills mismatch can change over time for individuals, and some mismatches can be considered healthy if observed when skill needs are undergoing transformation. It follows that not every formally detected skill gap is real, and that the very problem of skill shortage (reported by employers as the main re-

Table 4. **Views on the Key Skills Mismatch Problems** [Cedefop 2018a:16]

Mainstream view	Additional insights
Key problem: skill shortages Employers cannot find the right skills Graduates are ill-prepared for the skill needs of modern workplaces	Key problem: skill surpluses • The skills of a significant share of population are unrecognized or underutilized Low incidence of workplace learning in some sectors/occupations Stagnant task variety in some sectors
Skills mismatch: static Policy-makers should aim to match skill supply to skill demand	Skills mismatch: dynamic One-shot policy solutions to matching skills and jobs are short-lived Some skills mismatch can be healthy if associated with changing skill needs and continued skill formation
Skills mismatch: a cost Skill gaps are associated with lower productivity	Skills mismatch: an opportunity Some skill gaps reflect greater opportunities for continuing learning Transitions from overskilling to matched skills bring productivity gains
Lifelong learning: an individual responsibility Individuals should invest in adult training to shield against career interruptions and changing skill needs	Lifelong learning: a joint worker-firm responsibility Employer-provided training in workplaces has a greater marginal effect on workers' continuing skill development than off-the-job training

cruitment hurdle[3]) may in fact be the problem of skill surplus—unrecognition and underutilization of skills in the labor market—as well as ineffective recruitment and workforce development strategies. Finally, one-shot policy solutions to matching skills and jobs are often short-lived, so policy-makers should examine thoroughly all the possible causes and quality of the detected gaps before making any decisions to deal with mismatches.

2. Skills Mismatch Measurement in Cross-National Assessments

2.1 Approaches to measuring skills mismatch

Skill is a complex semantic construct, and its definition may vary greatly depending on the subject of research. Studies addressing skills mismatch define skill as any capability that satisfies some practical requirement of work [Handel, Valerio, Sanchez Puerta 2016:5]. That is, skills are not analyzed in isolation as some specific knowledge or personal characteristic; they should be directly relevant to job per-

[3] Genuine skill shortages are only observed in 12% of employer recruitment difficulties, while the rest can be attributed to firms' inability to offer a competitive salary or adopt a competitive recruitment strategy [Cedefop 2018a:42].

formance. Among the identified types of skills[4] (cognitive, non-cognitive/socioemotional/behavioral, and technical/job-specific), cognitive ones have been studied most extensively, largely due to the evidence of their positive macroeconomic effects and their capacity to predict professional success at the microeconomic level. General and higher-order cognitive skills are fundamental to any professional, as they are indispensable for acquiring occupation-specific skills [Ibid.:6].

Before proceeding to analysis of publications on skills mismatch measurement, it is important to emphasize the difficulty of measuring the "supply", or the level of proficiency across various skills. General cognitive skills that develop in the course of formal schooling are the easiest to measure, whereas skills that are in high demand among employers (job-specific, higher-order cognitive, and non-cognitive), acquired from informal institutions (life experience, workplaces, on-the-job training), are extremely hard to assess at the national and cross-national levels. The main reasons for that include the vast and growing variety of narrow skills required by specific jobs, which makes creating a universal measurement instrument an extremely challenging task.

Although researchers recognize unanimously the problem of skills mismatch and the important role of skills in achieving professional success, no consensus has been reached on the measurement methods so far, the major challenge being the lack of harmonized cross-country data on skills demand (skills required by employers) and supply (skills possessed by workers) with regard to a wide range of skills.

The existing approaches to measure skills mismatch represent adapted versions of the three major methods of measuring mismatches in education. There is much more literature on educational mismatch assessment methods because data on the mismatch between formal education and job requirements is more accessible and objective [Eurostat 2016]. The first assessment method is subjective self-reporting, i.e. self-assessment of matching between an individual's qualifications and the level required for successful job performance. The second one, objective measurement, is when labor market experts determine the education levels required for specific jobs or occupations and the degrees of matching those requirements. The third method is empirical and suggests that the required level of qualifications is estimated based on average levels of educational attainment within specific sectors or occupations.

We have identified three methods to assess skills mismatches based on the type of data on skills supply and demand (Table 5). The

[4] This classification is used by the World Bank [Skills Development. World Bank: http://www.worldbank.org/en/topic/skillsdevelopment]. The OECD distinguishes between cognitive, non-cognitive, and other skills, the latter including a number of varieties of narrower skills that may be classified as technical or job-specific [Skills. OECD: http://www.oecd.org/skills/].

Table 5. **Methods of Skills Mismatch Measurement**

Type of measurement	Demand for skills	Supply of skills	Mismatch measurement	Type of mismatch measured
Direct objective	Occupation profiles indicating required skill levels	Direct measurement	Comparing actual skill levels to required ones on a uniform scale	Underskilling Overskilling
Indirect	Indirect measures (employment rate, unemployment rate, overeducation rate, etc.)		Calculating a composite index of skill shortage/surplus	Skills mismatch (aggregate) Skill shortages
Direct subjective	Employer surveys		Subjective self-report of individual's skills as matched/ mismatched to current and/or prospective job requirements	Skill gaps Skill shortages Skill obsolescence
	–	Worker surveys		Underskilling Overskilling
	Linked employer-worker surveys			Skill gaps Under-/overskilling

indirect method uses indirect measures of skills supply and demand, the direct one compares the results of direct skill measurements to employer requirements, and the direct subjective one measures the gap using employer and/or worker surveys. Table 5 demonstrates that different methods may be used to assess the same type of mismatch, and combinations of methods result in mixed-methods approaches.

Let us now dwell on the examples of mismatch measures in each of the three assessment methods. Direct objective assessment measures short-run current mismatches (see Table 1) by comparing the individual level of skills to the one required for job performance. ACT WorkKeys assessments compare the proficiency levels needed for specific career clusters (e. g. "Locating Information Level 6" for "Economists") to the minimum scores achieved by examinees (e. g. Level 5 achieved). As a result, a skills mismatch (shortage, i. e. underskilling and skill gap) will be identified in this career cluster at the individual level. Aggregated skill benchmarks are created to represent the skill levels required for entry into 85% of the occupations in a given career cluster [ACT 2015].

Direct subjective assessment (surveys) also measures the short-run mismatches of "here and now" using self-report of skill gap and its size or, in case of employer surveys, expert reports. A 2014 survey of adult workers in 28 EU countries (European Skills and Jobs Survey) used six blocks of items to measure skills mismatches. In particular, the items asked participants to assess the level of skills needed to do their job on a scale of 0 to 100, the extent to which their skills were lower or higher than required to do their job on a scale of 0 to 5, and mismatches in specific skills (literacy, numeracy, ICT, etc.) on a

scale of 0 to 10 [Cedefop 2015]. With direct measurement methods, the final index of mismatch represents the share of workers who are mismatched to their jobs in one specific skill or in the whole skill set.

With indirect measurements, data on skills supply and demand is represented by indirect indicators, which make up a composite index allowing to measure aggregated mismatch or skill-specific shortages/surpluses. For example, European Skills Index is an aggregated index of 15 indicators broken down into three pillars. In particular, skills matching ranges between 0 and 100. This pillar includes two indicators of skill underutilization (long-term unemployment and underemployed part-timers) and three indicators of skills mismatch (overqualification rate among tertiary graduates, low-wage college-educated earners, and overall qualification mismatch) [Cedefop 2018b]. Section 2.2.3 presents an example of measure of skill-specific shortage.

Direct objective assessment is obviously the most reliable method of skill gap measurement, yet it is also the most difficult and costly one. One should also consider the limited range of skills that can be assessed using this method, especially on a regular basis and across countries[5]. An important advantage of direct measurements is that they identify skill gaps at the individual level, thus providing foundation for targeted measures to reduce those gaps. Subjective methods, despite being relatively easier to use, have a critical flaw of bias, which leads to essential variation and low reliability of measurements. Direct objective assessment, in addition to identifying a skill gap, may contribute to its reduction, while indirect measurements, for example, are helpful for monitoring trends in the balance of skills supply and demand. To summarize, objective and subjective assessments detect short-run mismatches, while long-run ones are measured indirectly.

2.2. Cross-national assessments of cognitive skills mismatches

2.2.1. PIAAC

Most publications and cross-country studies on skills mismatch have been based on the results of the OECD Programme for the International Assessment for Adult Competencies (PIAAC). Initially, the project did not aim to measure skill gaps; it was designed to assess general cognitive skills of adult workers, i. e. the supply of skills in the labor market. However, improving measures of skills mismatch has been made a key objective of development work for the second cycle of the survey (2018–2023) [Quintini 2017]. The first-cycle data provides both prerequisites that are necessary for assessing skills mismatch, i. e. direct objective measurement of cognitive skills offer and subjective measurement of skills demand in the form of worker surveys on skill use at work (Table 1A, Appendix). Accessibility and credibility of information on skills demand is a major challenge in cross-national assessments. The questionnaire module is based on the Job Requirement Approach (JRA), which consists in asking individuals about the

[5] For more details, see [Eurostat 2016].

Table 6. **Major approaches to measuring skills mismatch used in PIAAC-based cross-national assessments**

#	Approach	Source	Description
1	Self-report	PIAAC Background Questionnaire	Self-report on skills mismatch
2	Job Requirement Approach	Quintini (2012)	Comparing levels of skills (measured by PIAAC tests) and skill use at work (measured by self-report)
		Allen et al. (2013)	Standardized skill and skill use levels derived from [Quintini 2012]
3	Realized Match Approach	Perry, Wiederhold, Ackermann-Piek (2014)	Computing the median observed skill of workers (PIAAC results) employed in each occupation (two-digit ISCO-08) for every country
		Pellizzari, Fichen (2013)	Assigning levels of skills mismatch (based on Approach 1). For the group of well-matched (according to PIAAC tests) workers, competency bandwidths by country and occupation (one-digit ISCO-08) are derived according to average skill levels
		Pellizzari, Fichen (2017)	Assigning levels of skills mismatch (based on Approach 1). For the group of well-matched (according to PIAAC tests and self-report on skill use) workers, competency bandwidths by country and occupation (two-digit ISCO-08) are derived according to average skill levels

Source: [OECD2013a; OECD2015; OECD2018b; Quintini 2012; Perry et al. 2014; Pellizzari, Fichen 2017].

different types of tasks performed at work and the skills they use to perform them, and subsequently inferring to what extent their current skills are matched to requirements of their workplace. This approach is considered to provide a more objective description of skills than an approach relying on subjective self-assessments by individuals of the type and level of skills they possess [OECD2013b:5].

Below, methodological approaches to skills mismatch measurement are analyzed using the PIAAC data. Table 6 describes three major approaches, assigning respondents to one of the three categories—well-matched, underskilled, or overskilled.

The first method, self-report, is a direct subjective measure. The PIAAC uses this approach not only to measure the level of skill use (Table 1A, Appendix) but also to identify aggregated (non-skill-specific) mismatch in two Background Questionnaire items (Table 7). Due to low reliability of self-reported data, some researchers [Perry, Wiederhold, Ackermann-Piek 2014:148] assume that this questionnaire should not be used for measuring skills mismatch.

The second and third types of assessment represent mixed methods approaches, being based on objective data on skill levels (measured by PIAAC tests) and at the same time using subjective (self-reported) data.

Table 7. **Self-reported skills mismatch in the PIAAC Background Questionnaire**

Question 2. Do you feel that you need further training in order to cope well with your present duties?	Question 1. Do you feel that you have the skills to cope with more demanding duties than those you are required to perform in your current job?	
	Yes	No
Yes	Overskilled as well as underskilled	Underskilled
No	Overskilled	Well-matched

Source: [OECD2010; Perry, Wiederhold, Ackermann-Piek 2014:148].

Table 8. **Share of workers underskilled in numeracy (evidence from PIAAC), broken down by approach to skills mismatch measurement** (%)

	Self-report	JRA		RMA		
Country	PIAAC (BQ)	Quintini (2012)	Allen et al. (2013)	OECD (2013)	Perry Wiederhold, Ackermann-Piek (2014)	Pellizzari, Fichen (2017)
Germany	3.93 (0.46)	30.42 (0.84)	8.36 (0.60)	2.88 (0.35)	7.39 (0.76)	10.5 (0.033)
USA	2.33 (0.30)	44.71 (1.09)	9.65 (0.55)	4.54 (0.42)	7.65 (0.65)	13.9 (0.038)

Note: Standard error in parentheses. The sample consists of full-time employees between 16 and 65 years of age, excluding students and apprentices.
Source: [Perry, Wiederhold, Ackermann-Piek 2014:155, 159; Pellizzari, Fichen 2017:19]

Skills mismatch is measured by comparing proficiency levels assessed by PIAAC tests to skill use levels self-reported by PIAAC participants. Depending on how exactly this approach is used, mismatch measurement results may vary dramatically (Table 8). Although the problem of measure standardization has been solved [Allen et al. 2013], the method still has a major pitfall of being based on self-reports of PIAAC respondents, which undermines its reliability as workers tend to overstate their level of skill use [Hartog 2000].

The third method (see Table 6), Realized Match Approach, consists in deriving competency bandwidths for every country and every occupation based on PIAAC skill level tests. OECD researchers pioneered this method in 2013, but it was largely criticized for too broad occupation groupings, few career-specific observations, and using self-report data from PIAAC BQ. An alternative measure proposed in [Perry, Wiederhold, Ackermann-Piek 2014] avoids using self-reported information, thus making it possible to reach a minimum number of

observations by country-occupation of 30 and use the more detailed two-digit ISCO-08 categorization.

This approach was later upgraded [Pellizzari, Fichen 2017] by adding data from PIAAC skill use survey. Researchers computed the median observed skill of workers employed in each occupation and then defined minimum and maximum requirements in each occupation in an attempt to overcome the fundamental problem of all cross-national skills mismatch assessments, specifically the absence of direct objective or at least harmonized measures of skills demand. The authors admit that this new methodology still uses self-reported information by the workers—which is its major limitation—yet they are convinced that the potential distortions have been minimized [Ibid.:6].

Nevertheless, neither of the three PIAAC-based assessment methods analyzed above allows measuring skills mismatches by directly comparing levels of worker skills to those required for successful job performance (not those of skill use), thus placing limitations on actually using the measurement results in practice.

2.2.2. STEP Skills Measurement Program

The World Bank's STEP Skills Measurement Program provides another body of data to be used in cross-national skills mismatch assessments. Launched in 2010, the STEP was designed to measure skills mismatches in low- and middle-income countries, so it assesses both the demand for and supply of cognitive, socioemotional, and job-specific skills[6]. This is the widest-reaching cross-country study of skill gaps so far, which measures cognitive skills both objectively (PIAAC literacy test) and subjectively (self-report) and quantitatively estimates the demand for skills based on employer surveys (Table 9).

It was expected that skills mismatches would be assessed in linked household-employer surveys on skill use at work [Pierre et al. 2014:9]. However, the authors did not report the over- and underskillings estimated this way, as this approach implied using subjective information on skill use, and the available direct measures of skill-specific proficiency (literacy test results) were impossible to compare to employer survey data. Ultimately, the authors focused on measuring education mismatches, as data on education levels is more objective and reliable[7].

That is to say, skills mismatch assessments based on PIAAC data are not directly relevant to labor market needs, as skill shortages were measured using self-report data or average levels of proficiency. The STEP survey attempts to establish the relevance with labor market needs by combining direct skill measures with subjective assessments of skills demand. However, bringing this mixed methods approach to the cross-national level is challenged by the impossibility of

[6] For more details, see [Aedo et al. 2013].

[7] For more details, see [Handel, Valerio, Sánchez Puerta 2016:79–109].

Table 9. **Skills mismatch measurement in the STEP Employer Survey (for occupations Type A — Professionals)** [World Bank 2017]
Question 1: For each of the skills, indicate if there is a difference (gap) between what is required for the job and the current level of this skill in a typical worker
Question 2 (if a "Yes" was reported in Question 1): How large is the difference (gap) between the current skills and the required skills in a typical worker?

Skills	Question 1 Yes, there is a difference—1; No, there is no difference—2; This skill is not required for the job—3	Question 2 Small difference—1; Medium difference—2; Large difference—3
Can do calculations and work with numbers	1 2 3	1 2 3
Can read and write in English	1 2 3	1 2 3
Can read and write in another foreign language	1 2 3	1 2 3
Can find new and better ways to do things	1 2 3	1 2 3
Can stay on a long and difficult task until it is finished	1 2 3	1 2 3
Can be relied on to get things done	1 2 3	1 2 3
Can work well with others and listens to others' views	1 2 3	1 2 3
Can work well in very busy or difficult situations	1 2 3	1 2 3
Can continue in the face of challenging situations at work	1 2 3	1 2 3
Can easily adapt to new tasks or changes in the workplace	1 2 3	1 2 3
Can use a computer for making presentations and/or other advanced purposes like creating and managing databases, or using specialized computer programs, etc.	1 2 3	1 2 3
Can demonstrate specific technical skills relevant to the job	1 2 3	1 2 3

comparing non-standardized indicators of skills supply and demand—the current level of skills (grade or score obtained in a test) and the level required for job performance (judgmental opinion of an employer in a specific occupation and specific country, expressed during a survey)—as well as the lack of direct measures of skill levels and the impossibility of measuring directly the whole range of skills.

2.2.3. OECD Skills for Jobs Database

The OECD Skills for Jobs Database launched in 2017 is another source of cross-national data on skills mismatch[8]. This is an attempt to overcome the skills mismatch measurement pitfalls described above (subjective data, irrelevance to the labor market) and obtain the necessary cross-country information on skills that would be operational at both

[8] OECD Skills for Jobs: http://www.oecd.org/els/emp/skills-for-jobs-dataviz.htm

macro- and microeconomic levels, the latter involving individual decisions on educational trajectories and employee training and development. The database contains information on skill shortages and surpluses, education mismatches, and horizontal gaps for 35 skills (from cognitive to job-specific) disaggregated into knowledge areas from 40 OECD+ economies.

In the absence of direct objective cross-national measures of skills demand, the OECD uses a combination of indirect labor market signals. The resulting Skills Shortage Index (SSI) reveals skill-specific shortages/surpluses at the occupational level[9] in a country. The SSI is calculated in two stages.

At the first stage, the Occupational Shortage Index (OSI) is estimated, which is a composite indicator consisting of five components: hourly wage growth, total employment growth, growth in hours worked, overqualification growth, and unemployment rate. The choice of a composite index is justified as indicators within it not only complement one another but also smooth over random fluctuations in any one indicator. For instance, a combination of the former two components may have an opposite effect on demand for occupations, generating a shortage or a surplus of workers.

At the second stage, the estimated country-level OSIs are refined by calculating shortage indexes for each specific skill in every occupation. To do this, the OECD uses the US Department of Labor's Occupation Information Network (O*NET)[10,11]. O*NET represents a continuously updated database of knowledge and skills (cognitive, social, and technical) required from workers in each occupation in the US labor market. For each occupation, the O*NET database provides a matrix of skills by two dimensions, "importance" (on a scale from 1 to 5) and "level" required to perform job duties (on a scale from 0 to 7). The product of the two dimensions represents the skill-specific requirements for each occupation, which are used to compute the SSI.

The OECD Skills for Jobs Database is positively far ahead of all the other skills mismatch measurement instruments analyzed here as it uses unbiased data on skills demand; however, it is not free of limitations, either. First, skills mismatch data is derived from indirect indicators (labor market signals), and the resulting measure of skill imbalances rather describes skill needs. Second, researchers are doubtful whether it is correct to extrapolate the O*NET matrix of skills required for jobs in the US labor market to other countries [OECD2018b]. O*NET has already been applied in research on other economies[12], and the cross-country validity of O*NET scores described above has

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[9] List of occupations at the two-digit level of ISCO-08 (33 occupations in total).

[10] O*NET Resource Center: https://www.onetcenter.org/

[11] PIAAC data on skill requirements is not as detailed as those provided in O*NET and, for this reason, are not exploited in the Skills for Jobs Database.

[12] For more details, see [Aedo, Walker 2012; Aedo et al. 2013].

been formally tested by Handel [Handel 2012]. A caveat should, however, be raised about the use of O*NET to describe skills of occupations in low-income countries, as they differ significantly in terms of technology and regulatory context from the United States, which inevitably affects the skill content of certain occupations. Despite possible challenges in using the O*NET database, it remains the most comprehensive and crucial source for assessing skills in employment that exists, researchers admit [OECD2017:42].

3. Applicability of Cross-National Skills Mismatch Measurement Results and the Associated Problems

According to a survey of relevant ministries of 13 OECD countries, information obtained from skill anticipation and mismatch assessment exercises is actively used in education policies, most often in designing, updating, and revising curricula (over 90%) and providing information to students about labor market prospects (over 75%) [OECD2017:19]. Obviously, not only cross-country assessments but national surveys as well are used for those purposes, providing direct objective data that has many more chances of being applied and operationalized for decision making. The existing cross-national assessments of skills mismatch predominantly use mixed methods approaches, combining direct measurement of a narrow range of skills with subjective self-report of skill needs, this choice being dictated by the impossibility to obtain objective information on the skills demand.

In terms of potential applicability, measurements based on PIAAC and STEP data cannot be considered completely credible because of methodological limitations and flaws (Table 10). In the case of PIAAC, the major restrictions are self-reported data (including data on skill needs) and very limited implications (only two skills are measured). The prospects for using results of such assessment by educational institutions and other stakeholders are extremely limited; in fact, they are reduced to pure research. The STEP survey basically confined skills mismatch measurement to surveys (skill gaps reported by employers) and education mismatch assessment, being unable to measure skill imbalances.

The Skills Shortage Index from the OECD Skills for Jobs Database provides more reliable measures of skill shortages and surpluses. Despite the limitations (reduction to self-report on skill needs), this is the most operational database for all the stakeholders including educational institutions and students. From day one, it was designed for use by a broad public. The database is available in two modes, at OECD.Stat to be used by researchers and on a separate website with a friendly interface[13], which provides an interactive cross-country comparison of skill-specific mismatches and the “Change career” service allowing to discover which skills, abilities, and knowledge one

[13] OECD Skills for Jobs: https://www.oecdskillsforjobsdatabase.org

Table 10. **Limitations of cognitive skill measurement methods and results in cross-national assessments**

Database (developer)	Method	Type of mismatch	Measurement results	Flaws
PIAAC (OECD, since 2008)	Mixed methods (self-report + direct skill level measurement + surveys on skill use at work)	Underskilling Overskilling	Groups of underskilled, well-matched, and overskilled workers are identified for two cognitive skills in each occupation	Based on non-objective data: subjective assessment of skill needs and self-report of skill gaps; Only two skills are measured
STEP (World Bank, since 2010)	Direct subjective (employer and employee surveys) Mixed methods (direct skill level measurement + surveys on skill use at work)	Skill gaps	Groups of underskilled, well-matched, and overskilled workers are identified at the educational level; Skill gaps are identified based on employer surveys on satisfaction with worker skills	Skills mismatch measurement is reduced to qualifications mismatch measurement
OECD Skills for Jobs Database, Skills Shortage Index (OECD, since 2017)	Indirect (indicators of demand for occupations are specified using O*NET data on skill-specific requirements in each occupation)	Skill shortages	Skill Surplus/Shortage Indexes are computed for 35 skills in each occupation (at the two-digit level of ISCO-08) across 40 economies	Reduced to skill need measurement

might need to strengthen depending on their current or desired occupation in a specific country.

The characteristics of skills mismatch measurement specified in Table 10 impose severe limitations on measurement results and their interpretation. Skills mismatch data varies greatly depending on the method used, not only at the quantitative level (e. g. divergences in PIAAC data, see Table 8) but at the qualitative one as well. As a result, it is often unclear whether the problem of mismatch is actually real and, if it is, whether it is a surplus or shortage.

Let us analyze the results of skills mismatch measurement across 19 OECD countries in studies using data from PIAAC and the OECD Skills for Jobs Database. Four degrees of imbalance are used to compare the results obtained by the two methods: “shortage”, “critical shortage”, “surplus”, and “critical surplus”. For the OECD Skills Shortage Index, degrees are established as follows. The SSI takes values from 1 to –1, where positive values correspond to shortage, and negative ones, to surplus of skills. OECD experts [OECD2017:51] suggest defining critical shortage as the observations in the top quartile of the positive skill imbalance values across countries and skills, and critical surplus, accordingly, as the observations in the bottom quar-

Table 11. **Discrepancies in numeracy (mathematical) skills mismatch assessment**

Country	OECD Skills Shortage Index		Skills mismatch (assessed in [Pellizzari, Fichen, 2017] using PIAAC data)		
	Value	Shortage/ Surplus	Shortage value	Surplus value	Shortage/ Surplus
Finland	0.49	Critical shortage	0.04	0.063	Surplus
Italy	0.29	Critical shortage	0.08	0.141	Surplus
Spain	0.269	Critical shortage	0.151	0.250	Critical surplus
Denmark	0.243	Critical shortage	0.062	0.096	Surplus
Germany	0.235	Critical shortage	0.105	0.243	Critical surplus
Austria	0.183	Critical shortage	0.018	0.148	Surplus
Ireland	0.176	Critical shortage	0.121	0.153	Surplus
Czech Republic	0.17	Critical shortage	0.038	0.124	Surplus
Slovakia	0.16	Shortage	0.043	0.176	Critical surplus
Norway	0.156	Shortage	0.074	0.078	Surplus
Netherlands	0.15	Shortage	0.038	0.058	Surplus
France	0.109	Shortage	0.043	0.065	Surplus
Canada	0.098	Shortage	0.028	0.098	Surplus
USA	0.09	Shortage	0.139	0.263	Critical surplus
Sweden	0.089	Shortage	0.075	0.081	Surplus
Belgium	0.075	Shortage	0.059	0.082	Surplus
Great Britain	0.068	Shortage	0.069	0.108	Surplus
Poland	–0.007	Surplus	0.107	0.155	Surplus
Estonia	–0.03	Surplus	0.031	0.059	Surplus

Note: The OECD Skills Shortage Index for 2015; skill imbalances computed in [Pellizzari, Fichen 2017] for 2008–2013.
Source: [Pellizzari, Fichen 2017:19]; OECD.Stat. Skills for Jobs Database: https://stats.oecd.org

tile of the negative values. PIAAC-based skills mismatch measurements represent shares of well-matched and mismatched (over- or underskilled) workers. In order to distribute these results among the four degrees of imbalance, we assume that skill surplus is a prevailing problem in case the share of overskilled workers is higher than that of underskilled ones, and skill shortage prevails in the opposite case. The PIAAC first-cycle average was used as a benchmark to demarcate the critical shortage (0.087, or 8.7%) and critical surplus (0.167, or 16.7%) percentiles.

In assessing numeracy mismatch, the two methods yield divergent results in 17 out of 19 countries (Table 11). Calculations [Pellizzari, Fichen 2017] based on PIAAC data reveal skill imbalances (25.4%) in the first-cycle countries, yet surplus (16.7%) prevails over shortage (8.7%). It means that skill shortage is not a prevailing problem according to PIAAC-based computations—but the 2015 OECD Skills for Jobs Database shows a different picture of the skills imbalance, revealing skill shortages in 17 out of 19 countries, including eight cases of critical shortage.

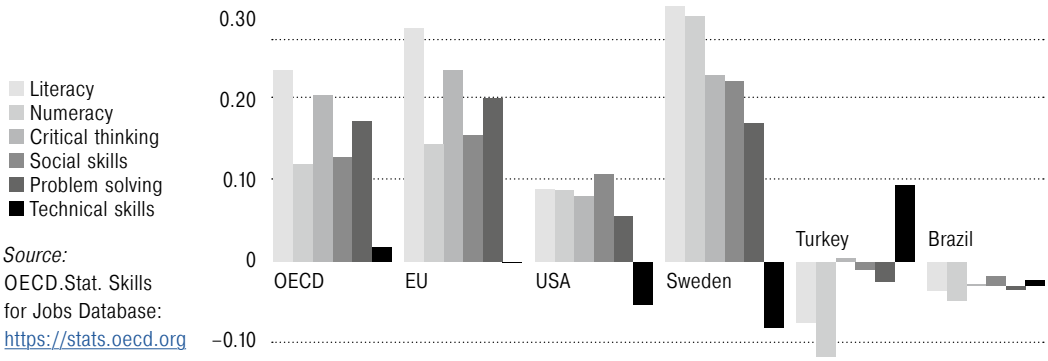
Therefore, a "head-on" comparison of skills mismatch assessments using different methods of measurement does not allow inferring the quality of the existing skill imbalance and only confirms the variation in measurements and the existence of the measurement problem. However, if measurements from both studies are analyzed separately with allowance made for the methodological characteristics, meaningful and uncontroversial inferences can be achieved.

The Skills for Jobs Database uses an indirect approach that measures a long-run skill match/mismatch. Skill shortage indexes for 35 skills in each occupation across 42 countries show that skill shortage mostly affects cognitive competencies. Nearly all OECD economies experience a shortage of cognitive skills required to perform non-routine tasks, while technical skills used for routine manual tasks are largely in surplus [OECD2017:51]. The imbalance typical of OECD countries contrasts strikingly the one discovered in low- and middle-income countries (Fig. 2). For example, Brazil and Turkey demonstrate a shortage of technical skills and a surplus in the majority of cognitive ones. Consequently, the long-run shortage of skills in the OECD countries proves the structural shift in the labor markets of high-income economies, specifically the polarization of skill needs as a result of manufacturing automation and gradual eradication of routine tasks (in a broader sense, job polarization).

PIAAC-based measurements of cognitive skills imbalances use direct objective and direct subjective approaches, thus establishing short-run mismatches. According to this type of measurement, surplus of general cognitive skills prevails over shortage, which is not in line with the long-run cognitive skills imbalance measured by the SSI. Yet, much more importantly than simply confirming again the urgency of the skill surplus problem for high-income countries, PIAAC-based assessments expose the "two-humped" shape of the mismatch distribution, i. e. nearly equal shares of overskilled and underskilled workers in a number of countries (Fig. 3). Taking into account the methodological characteristics of this skills mismatch measurement approach (use of self-report data on skill use as a proxy for skill needs/requirements), it may be suggested that the main source of both "humps" is the problem of skill underutilization, not skill level requirements.

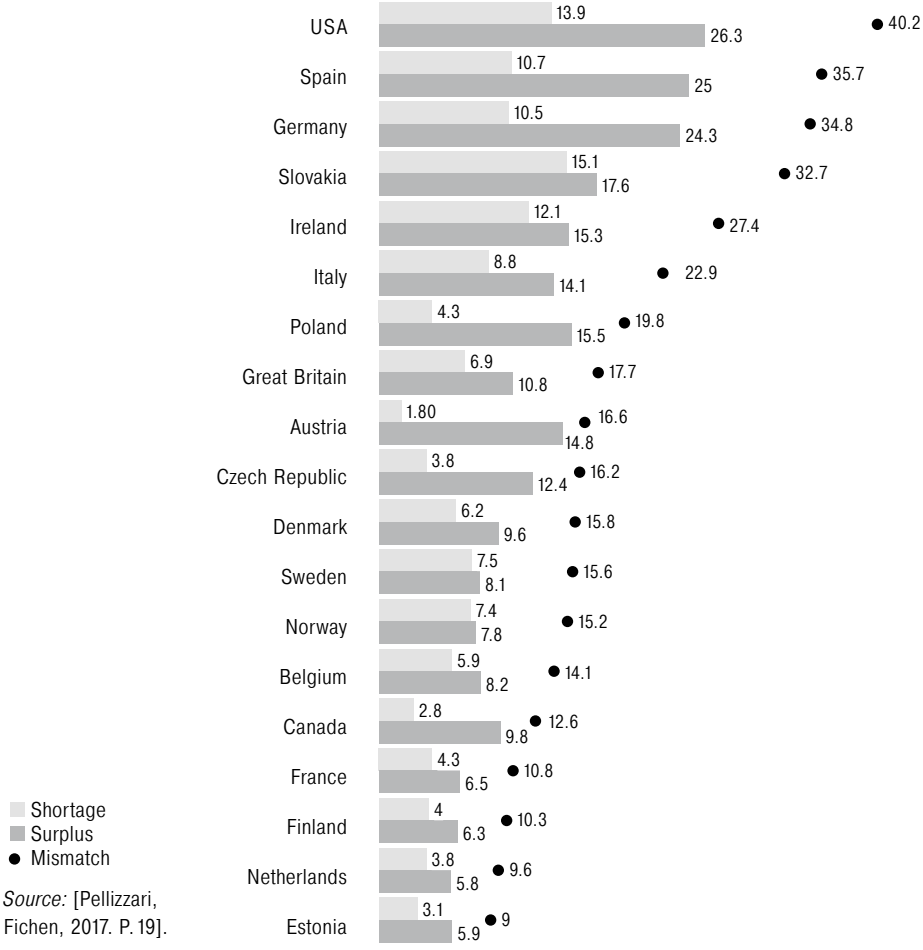
As we can see, apart from showing structural skills imbalances, cross-national data on long-run skills mismatches obtained us-

Figure 2. **Skill Shortage Index in some OECD and non-OECD countries (positive values — shortage)**



Source: OECD.Stat. Skills for Jobs Database: https://stats.oecd.org

Figure 3. **Skills mismatch by country—numeracy** (%)



Source: [Pellizzari, Fichen, 2017. P. 19].

ing indirect indicators (OECD Skills for Jobs) can be used by educational institutions as a source of information on the demand for skills across occupations and countries as well as by students and workers as guidance for choosing or changing their educational/career trajectory. On the other hand, PIAAC-based assessments measuring short-run skills mismatches are rather of interest to researchers but hardly applicable in practice, not only because they address very few skills but also because of some methodological characteristics (self-reported data on skills demand) and the associated interpretation challenges. Still, this assessment approach contributes significantly to the evolution of the debate on whether demand for skills in the labor market should be measured by job requirements or actual levels of skill use at work.

Conclusion

The international discourse on skills mismatch has been augmenting, the alarmist skill gaps narrative infiltrating more and more national agendas. While researchers and employers are debating over the size and urgency of the skills mismatch problem, political decisions are made to reduce the gap at the national level.

This article attempts to unravel the tangle of controversies and shed light on the issue of skills mismatch as a micro phenomenon at the level of specific skills and individuals. As it turns out, skills mismatch can take various forms depending on the quality of gap and the party reporting it, and zero gap is not always the sought-for result. The high dispersion of opinions regarding skill imbalances is explained by difficulties of mismatch measurement and interpretation caused by limited availability of objective data on the demand for and supply of specific skills. It is no coincidence that overeducation remains the most elaborated manifestation of skills mismatch.

The use of subjective data on skill needs and the limited number of skills tested are the main reasons why cross-country assessments cannot be relied upon. Consequently, the indexes of cognitive skills mismatch provided by the major cross-national studies (PIAAC, STEP) are not operational, being only useful for the purpose of fundamental research. However, the empirical results of those studies allow bringing to a broad public the issue of whether it is skill underutilization or formal education flaws that should be considered the root of the mismatch problem. An exception is the skills mismatch assessment based on the new OECD database, which measures long-run imbalances. Not only does this data on skill needs allow to monitor structural shifts in the skills mismatch but it can also be applied by a wide range of users, first of all educational institutions, students, and workers.

Since the OECD-based instrument is the only one of all the major cross-country studies measuring skills mismatch that can be regarded as potentially operational to be used by educational institu-

tions, colleges will have to utilize a broader array of skills mismatch data obtained at the national level in order to achieve their strategic and tactical objectives.

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Appendix

Table 1A. **PIAAC module on the use of skills at work**

Type of items	Items	Response Options
Skill Use Work—Literacy—Reading Scale G_Q01 (items G_Q01a, G_Q01b, G_Q01c, G_Q01d, G_Q01e, G_Q01f, G_Q01g, and G_Q01h)	How often (do/did) you read or use information from each of the following as part of your main job? directions or instructions letters, memos or emails articles in newspapers, magazines or newsletters reports, articles, magazines or journals books manuals or reference materials bills, invoices, bank statements or other financial statements diagrams, maps or schematics	Never Less than once a month Less than once a week but at least once a month At least once a week but not every day Every day
Skill Use Work—Literacy—Writing Scale G_Q02 (items G_Q02a, G_Q02b, G_Q02c, and G_Q02d)	How often (do/did) you write or fill out each of the following as part of your main job? letters, memos or emails articles in newspapers, magazines or newsletters reports forms	
Skill Use Work—Numeracy Scale G_Q03 (items G_Q03a, G_Q03b, G_Q03c, G_Q03d, G_Q03e, G_Q03f, G_Q03g, and G_Q03h)	In your main job, how often (do/did) you use arithmetic or mathematics to: calculate prices, costs or budgets? use or calculate fractions or percentages? use a calculator (either hand-held or computer-based)? prepare charts, graphs or tables? use simple algebra or formulas? use advanced math or statistics (complex algebra, trigonometry or regression techniques)?	
Skill Use Work—ICT—Internet and Computer Scale G_Q05 (items G_Q05a, G_Q05b, G_Q05c, G_Q05d, G_Q05e, G_Q05f, G_Q05g, and G_Q05h)	In your main job, how often (do/did) you: use email? use the Internet in order to better understand issues related to your work? conduct transactions on the Internet, for example buying or selling products or services, or banking? use spreadsheet software, for example Excel? use a word processor, for example Word? use a programming language to program or write computer code? participate in real-time discussions on the internet, for example online conferences, or chat groups?	

Source: [OECD2010; OECD2013b: 31].