Skill Mismatch Research: Skill Dimensions in Vocational Education and Training

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Abstract

The purpose of this chapter is to contribute to the understanding of skill mismatches, by providing a comprehensive review of the various concepts, dynamic processes, and consequences as well as emerging trends in skill mismatch research. A skill can be understood as either the nature of the skill in itself (work ability or competence) or the individual worker or workforce. Thus, a skill mismatch in terms

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of the nature of skills is the qualitative discrepancy between what is possessed by an individual and what is needed, whereas a mismatch in terms of the workforce is the quantitative discrepancy between supply and demand of workers. Past researchers have proposed a variety of skill mismatch types according to whether the skills are viewed qualitatively or quantitatively and to the scope in which the mismatch phenomenon covers. The research trends surrounding the concept of skill mismatch have developed greatly since its beginnings when only indirect proxies were used. Now, various research topics on skill mismatch are possible as there is more development in data of skill mismatches.

Keywords
Skill mismatch · Skill dimension · Skill types · Qualification · Vocational education · Vocational training · Mismatch research

Introduction

Since the start of the skill-biased technological change in the economy in 1990, the term skills as "a new global currency" has gained prominence in international education and training policies; many policies emphasize employability of students through the linkage of education and training systems to the labor market to respond to the increasing demand of skilled workforce (Desjardins and Rubenson 2011; Keevy and Chakroun 2015; OECD 2012). However, as the supply for skills has increased due to these policies, another major concern that arose is the problem of skill mismatch, the solution, to which is now deemed as the next important agenda in many countries (Desjardins and Rubenson 2011). As such, the European Commission (2010) has presented mismatches such as skill shortages and skill gaps as some major challenges to be addressed in the labor market, and OECD (2015) has refocused its priority to discussions regarding youth skill mismatch.

Skill mismatch, a very complex and dynamic phenomenon increasingly spreading across OECD countries (Quintini 2011), is a disparity between skill supply and demand, either quantitatively or qualitatively (Cedefop 2009). Interest in the skill mismatch phenomenon began when the supply of college graduates in the United States in the 1970s exceeded the demand in the industry, and the scope of the concept subsequently expanded (ILO 2014). As the unemployment rate of young people increased due to the global economic crisis in 2008, interest in skill mismatch also increased (Cappelli 2015; Cedefop 2015a). In addition, the skill mismatch phenomenon can be seen at various levels, such as individual worker, organization (Cedefop 2010a), and country (Cedefop 2009, 2010a).

However, researchers from different academic fields and various institutions have defined skill mismatches differently. Due to this lack of unified conceptual understanding, problems arise when these concepts are operationalized during studies about skills and skill mismatch, leading to incomparable statistical data (Vallas 1990).

Thus, the focus of this chapter is to review and describe the concept of skills as a multidimensional notion. This is achieved by reviewing past literature including scholarly journals and reports from international organizations, such as reports from ILO, Cedefop, and UNESCO on "skills", "competence", "skill mismatch", and "mismatch". The aim of this review is to contribute to the growing literature on skills and skill mismatch and to act as a conceptual guideline for empirical research.

Concept of Skills and Skill Dimensions

Concept of Skills

There are a variety of definitions and understanding about skills in the literature, which are conceptualized based on different perspectives and purpose of the researches. Skills can either be described as a psychomotor domain of learning, or as a work ability, or as the entire set of workforce skills themselves.

Skills Described as a Learning Domain

Bloom has identified three domains for developing educational objectives, which are the cognitive, affective, and psychomotor domains (Simpson 1966). Skills, according to some researchers such as Gagne (1949), Mohr (1960), Seashore (1940), can refer to behavior or an action that pertains to only a small part of these learning domains which is the psychomotor domain of learning of Bloom's Taxonomy of Learning (as cited in Simpson 1971, p. 11). For instance, Pear (1927), one of the earliest researchers to define skill, refers to skill as "the quality and quantity of motor performance of an individual" (as cited in Winterton, Delamare-Le Deist, and Stringfellow 2006, p. 10). Since then, other researchers have started to include not only physical qualities of an individual but also the mental function or cognitive performance of an individual. For instance, according to Hans Renold (as cited in Winterton et al. 2006, p. 10), skill is "any combination, useful to industry, of mental and physical qualities which require considerable training to acquire."

Skills Described as Work Ability

Skills could also be viewed as a holistic construct, as it is recently used interchangeably with competence (OECD 2011b) and covers all the cognitive, psychomotor, and affective domains of Bloom's taxonomy (Cedefop 2013b; Keevy and Chakroun 2015). Skills (or competences) are defined as "the bundle of knowledge, attributes and capacities that can be learned which enables individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning" (OECD 2011b, p.12). This not only describes about what skills are demanded to perform a task successfully, but they also allow for the understanding of how these skills can be achieved and assessed. As the emphasis on enhancing work productivity has increased, skills could be broadly described as ability to

perform a task or a job optimally (Cedefop 2009; ILO 2008; Stoevaks 2017). For instance, Stoevak (2017, p. 11) refers to skill as "the innate or learned ability to apply the knowledge acquired through experience, study, practice or instruction, and to perform tasks and duties required by a given job." While Welford (1968, as cited in Winterton et al. 2006, p. 11) mentioned that skill is a "combination of factors resulting in 'competent, expert, rapid and accurate performance'", he regarded this as equally applicable to manual operations and mental activities. In many researches, skill is mostly defined through the educational-economist point of view, which views skills as a form of human capital. Skills from this perspective are regarded as acquired technical abilities, such as cognitive skills and non-cognitive skills, which contribute to higher productivity in the labor market and also in return able to provide the skilled person with better benefits such as higher wages (Green 2011; Plesca and Summerfield 2014).

Skills Described as Skilled Worker

In the perspective of demand and supply of skills in the labor market, the term "skills" may refer to an individual skilled worker, a group of skilled workers in a firm or in an occupation, or as the entire population of skilled workforce in the labor market. For example, Bejaković and Mrnjavac (2014) asserted that skill shortage appears when the number of individuals with certain skills is lower than the number of jobs requiring those skills, and skill surplus occurs in the opposite situation. Here, "skills" refer to an individual skilled worker. Cappelli (2015) referred to the problem of shortages of engineers or information technology specialists as "skill shortage," whereby the term "skills" refers to the number of engineers and specialist demanded in the occupation. Similarly, Reymen et al. (2015) have reported a problem of occupation-specific labor shortages or quantitative skill shortages within EU member states, which is a result of the lack of number of jobseekers with the demanded skills applying to recruiting companies. These skill shortages can be alleviated by attracting foreign workers, which also represents a large population of skilled worker supplied across nations and regions. Rothwell (2015) also refers to skilled technical workers as the group of workers working in middle-skilled occupations such as trade workers, technicians, and craftsman.

Skill Dimensions and Multidimensionality

As the previous section has shown, the different conceptualization of skills in literature, this section seeks to clarify the different multidimension of skills. Skill dimensions refer to the different aspects or angles in which skills can be viewed. In the context of vocational education and training, skills are multidimensional in nature as these three dimensions: skill type, skill level, and skill content. Referring to Fig. 1, the number of levels and the extent of the skill type and content are not fixed, but rather they are dependent upon the focus and context of the researchers. More often, a literary research for "skill dimension" or "competency dimension" yields a number of studies that refer only to the skill type as a dimension (Brewer and Coryn 2015; Müller and Turner 2010). However, skills are not one-dimensional, as each skill type could be arranged into hierarchical levels depending on the complexity and the difficulty of the

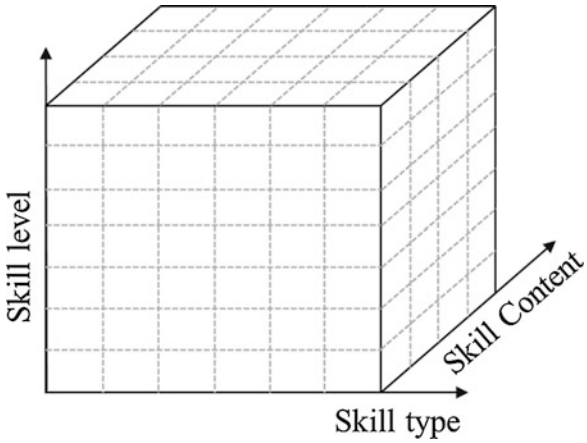

Fig. 1 Three dimensions of skills

skills demanded in a job (Chang and Birkett 2004; Na et al. 2003; Stoevaks 2017). While skill type and skill level are more broad and generic, the specific descriptions of required skills within a given level can be understood as skill content.

Types of Skills

Skill type refers to a number of skills that are grouped together due to their common characteristics or qualities. Various skill frameworks exist, each proposing different lists of skills and their types, as these skill frameworks were developed for certain purposes and according to different national context. For instance, ACT WorkKeys (2014) was developed as a standard for assessing basic skills, whereas some frameworks are developed as a standard reference for curriculum developers to develop curriculum that could cover most of the skills demanded by the industry (CareerOneStop 2017). Thus, it is difficult to generalize the whole list of skills into definite categories. Analysis of several frameworks, as shown in Appendix 1, indicated that there are commonalities in the skill types and these major skill types can be (i) core skills, (ii) industry-specific skills, and (iii) occupation or job-specific skills.

Core Skills

Core skills are skills which are not related to work performance but are important for lifelong learning, adaptability, and flexibility in work (Brewer and Coryn 2015). Across the frameworks and studies analyzed, it could be seen that core skills can be further clustered into three major groups, which are basic skills, personal and interpersonal skills, and other core skills needed for work. Basic skills refer to the most rudimentary skills that must first be acquired in order to receive further education and training and before a worker can obtain other skills such as other work skills. These include reading, writing, mathematics, and communication skills including listening and speaking (ACT WorkKeys 2014; Brewer and Coryn 2015; CareerOneStop 2017; Casner-Lotto and Barrington 2006; O*NET Resource Center 2017; O'Neil et al. 1992; SCANS 1991; Stoevaks 2017; UNESCO 2014).

These frameworks have also identified personal competencies which are not only important for a worker to thrive within a workplace, such as self-management, self-esteem, and dependability, but also important in maintaining healthy social relationships with co-workers or clients, such as interpersonal competencies, social skills, honesty, and integrity. An individual's lifelong learning and initiative for learning was also identified as an important skill in several frameworks (CareerOneStop 2017; Casner-Lotto and Barrington 2006; Curtis and McKenzie 2001). Other core skills such as higher complex thinking skills for problem-solving; skills to manage financial resources, time and human resources, and information literacy; and skills to apply technology in the workplace have been commonly identified across all of these frameworks. Some frameworks have included leadership (Brewer and Coryn 2015; Casner-Lotto and Barrington 2006) and fundamental skills in business management (CareerOneStop 2017; Na et al. 2003).

Although core skills are basic, each occupation may demand the same skill with a different level of proficiency. For example, writing skills in SCANS can be divided according to five levels, whereby the first level includes basic recoding of information such as writing a simple job application, whereas level five refers to more complex writing such as writing synthesized information from different sources (Bramucci et al. 2000). Some occupations require level one of basic writing skills at entry level, while other occupations like journalists will require level five of basic writing skills at entry level.

Industry-Specific Skill Clusters

Several frameworks have also identified a skill type that is specific to industry or that is common to occupations within the same industry (CareerOneStop 2017; Na et al. 2003; Singapore Workforce Development Agency 2017). In other words, the skills that are contained within an industry-specific skill cluster can be utilized transferably in several different occupations which stem from a similar family of occupations or professions (Geel and Backes-Gellner 2009). For instance, according to the state of Minnesota (CareerOneStop 2017), a competency model for automation includes two tiers for industry skills, which are industry-wide technical competencies (e.g., design and development life cycles, operations management skills) and industry-sector technical competencies (e.g., context of automation, industrial automation).

Developing industry-specific skills in a workforce has several important implications, especially for labor mobility. Evidence has shown that displaced workers who find new jobs in different occupations of the same industry earn higher than those who switched industries (Weinberg 2001). Industry-specific skills can help reduce the adverse effects of labor market shocks, such as economic failure or occupation becoming obsolete due to advent of artificial intelligence. Moreover, the combination or cluster of skills can be applied in the development of curriculum of an integrated modular training approach for a group of occupation (Randhawa 1978).

Job-Specific Skills

Job-specific skills are also called technical skills (Brewer and Coryn 2015; Stoevaks 2017), vocational skills (Brewer and Coryn 2015), specialized skills (UNESCO,

2014), or occupational competencies (CareerOneStop 2017; Na et al. 2003; Singapore Workforce Development Agency 2017). Job-specific skills are skills required in a certain type of occupation that enable workers to gain benefits in terms of profits or opportunities for better and higher-wage jobs (Brewer and Coryn 2015). Job-specific skills can include specialist knowledge needed to perform job duties, knowledge of particular products or services produced, ability of operating specialized technical tools and machinery, and knowledge of materials (Stoevaks 2017).

Levels of Skills

Skill level means the position of skills which is assigned to a rank depending on its complexity and its difficulty. Skill levels have a variety of meanings. Depending on the context, it can broadly refer to the skill level based on (i) performance level (Chang and Birkett 2004; Na et al. 2003); (ii) education level, which in earlier researches is taken as an approximate measure skill; (iii) grade level of qualification or certification (Na et al. 2010; Na et al. 2011; Uh et al. 2015); (iv) required skill level to perform a particular occupation or job (ILO 2008; Stoevaks 2017); and (v) the levels or grades that express a successful worker in a National Qualification Framework (Cedefop 2013a, b). Knowing the level of a skill in advance can be useful for measuring skill, assessment and qualification design, education program, and mutual recognition agreement.

Skill Level Based on Individual's Level of Proficiency

Skill levels could be reflected based on the individuals' level of performance. For example, Na et al. (2003) reviewed about the levels of skills that can be applied during the assessment of a worker's basic competencies and have applied three levels of basic competencies, in their research: high, middle, and low level. These competency levels were derived through a systematic review of various literature including SCANS levels of proficiency, which include five levels from preparatory to specialist and the levels in O*NET (Na et al. 2003), and are based on the level of proficiency an individual is expected to perform in a task or job.

In another example by Chang and Birkett (2004), the dimension competency includes individual attributes, task performance, and organizational context, which is set on a hierarchical level based on Dreyfus and Dreyfus' (1980) expertise levels (Chang and Birkett 2004). Here, the skills that are expected from a novice worker are less complex than those who are more proficient in the field and have worked for a longer period. Dreyfus and Dreyfus (1980) levels have been used in many researchers for mapping the proficiency level of a worker (Gannon et al. 2016).

Skill Level as Level of Educational Attainment

Educational levels can serve as an indirect signal for skills and competence (Eurostat 2016). The latest 2011 International Standard Classification of Education has eight levels in total (UNESCO Institute for Statistics, 2012). These levels show the different steps during an educational progression, whereby each step or level has a different degree of complexity and specialization of the content of an education

program. However, the education programs that an individual has participated in or has successfully completed are only an approximation of the skills, knowledge, and competencies mastered at the time of completion (UNESCO Institute for Statistics 2012). It does not include the complete skills obtained outside of the education program. Several researchers (Fouarge et al. 2013; Steedman and McIntosh 2001) have used the ISCED to define low-skilled individuals as individuals who are at ISCED level two or lower or those who completed lower secondary school or lower, as low-skilled or low-educated individuals, in their research. Conventionally, the minimum level of education depicted by ISCED required in an occupation has always been focused more. Therefore, in many researches, skill mismatch was studied using academic ability instead of skill level.

Skill Level as Grade Level of Qualification or Certification

The grade of a qualification is also another aspect of skill level. For instance, in the UK, the NVQ level consists of five levels (UK NARIC 2017), while in Sri Lanka, there are seven levels of National Vocational Qualification (ADB 2011). In Korea, the National Technical Qualification has five levels of qualification which includes craftsman, industrial engineer, engineer, master craftsman, and professional engineer (Na et al. 2010).

Moreover, within a specific qualification level, a particular a certificate can be divided into several levels. Na et al. (2011) proposed three grade levels of basic competencies certificate depending on the passing mark of assessment. For example, those who had obtained a passing criterion of more than 90% in an assessment of basic competencies can be given certificate level 1, while those with a score of over 75% could be eligible for certificate level 2 (Na et al. 2011). Similarly, in Korea, certifications for vocational trainers are also divided into three grades which reflect their skill levels: 1 to 3, depending on the length of their initial training program, participation in professional development programs, and experience in teaching (Uh et al. 2015).

Skill Level as Levels in Occupational Standards

In this perspective, skill level can be determined according to the complexity and difficulty of the required skills to perform a specific occupation (Stoevaks 2017). While some researchers such as Stoevaks (2017) categorize the level broadly to low-level, moderate-level, and advanced-level occupation, the International Standard Classification of Occupations (ILO 2008) offers more explanation on the meaning of skill levels. According to the International Standard Classification of Occupation (ILO 2008), two dimensions of skill are used to arrange occupations into groups which is skill level and skill specialization. The concept of skill level is applied mainly at the top (major group) level of the classification.

However, it is important to note that the main purpose of educational or occupational and skill classifications such as those in the table below was to ease statistical data collection and information. Several problems will arise if researchers rely too much on educational and occupational classification to garner information on skills

because jobs and tasks may not be updated frequently into the ISCO classification (Beblavý et al. 2016; Martinaitis 2010).

Skill Levels in a National Qualification Framework

Qualification framework is a standard instrument to develop and classify qualifications according to fixed criteria in the form of level descriptors (Tuck 2007). It is a framework that can be compared based on the interchangeability of various qualifications in the qualification framework. The levels in NQF represent comparable standards that can be recognized for achieving the level of qualification required to engage in a particular occupation. For instance, EQF and ASEANQF have eight levels, while the Southern African Development Community Qualification framework has ten levels. The number of qualification levels in some countries is determined based on the characteristic and range of their own national qualification system, their own learning outcomes in existing curricula, and programs, based on benchmarking to regional qualification frameworks such as EQF, QF-EHEA descriptors, or Bologna descriptors which is adopted to suit national context (Cedefop 2013a, b) and linkage to Bloom taxonomy or level of learning (Keevy and Chakroun 2015). It is very useful for promoting the movement of people in the global society. It is important to emphasize that skill level is finally considered in comparing and judging this. NQF qualifies a certain level of manpower rather than a complex level of skill, because it is a framework that judges and recognizes a certain degree of difficulty on the assumption that there are various paths instead of one path. Qualification frameworks were developed to facilitate international mobility as it integrates all the skill levels in educational attainment, academic and vocational qualification standards, occupational standards, as well as the levels of proficiency (levels of competency).

Skill Contents

Skill content is the specific component and composition of skills needed in an occupation. ISCO 2008 refers to skill content as skill specialization in each occupation. In ISCO, within each major group, occupations are arranged into unit groups, minor groups, and sub-major groups, primarily on the basis of aspects of the specific skills that are needed in each group (ILO 2008). This skill specialization is considered in terms of four components, which are the field of knowledge required, the tools and machinery used, and the materials worked on or within an occupation.

An occupation itself can be deconstructed into a hierarchy such as job, a task, and an element of a task. Each of this hierarchical level of occupation requires specific components of skills, which includes competencies, as well as tools required, the procedures, and work processes. The competencies are the combination of knowledge, skills, and attitude (Cedefop 2013a), which means that an individual has applied knowledge and skills with their own autonomy and responsibility to perform a task successfully (Cedefop 2013a) (Fig. 2).

Understanding about skill contents and its components have important implications for an individual's acquisition of skills. When creating curriculums for

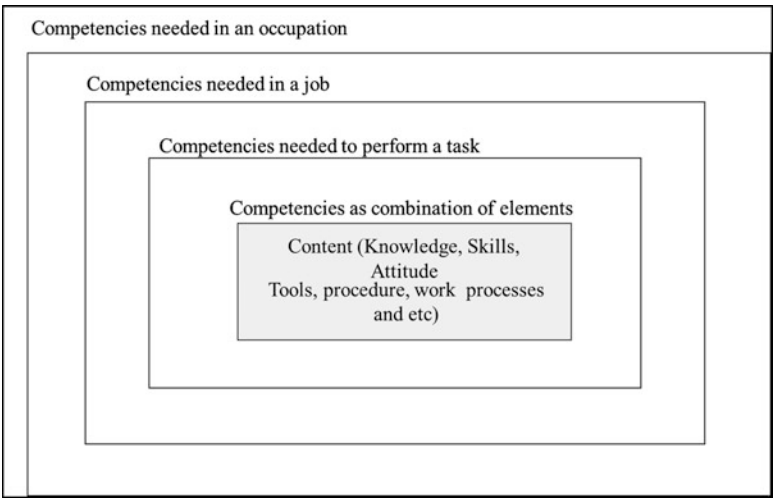

Fig. 2 Content of skill by hierarchy of occupation

delivering the skills needed, developers have always focused on trying to develop contents that could deliver the skill type that is proposed in frameworks. However, skill types and its content vary according to levels, and most skill content only refers to broad skill specifications of an occupation or a job. Recently, employer surveys indicate that occupation-specific skills are no longer sufficient to meet the needs of the labor market (OECD 2011a). Thus, for vocational education and training, developers should consider a systematic evaluation of knowledge, skills, and attitude needed to perform a task, the tools, its procedure, and work processes that are required especially for an element of tasks to guide the curriculum development so that proper skill sets are delivered.

Concept and Types of Skill Mismatches

Definition of Skill Mismatch

There are numerous definitions in literature, whereby, as summarized in Table 1, each of these definitions has a different focus depending on the nature of the skill data.

Researchers which view concept of skills as workforce have defined skill mismatch as the as the discrepancy between quantity of skilled worker demanded by the labor market and that is supplied (European Parliament 2015; Liu et al. 2016; Manacorda and Petrongolo 1999). While some focused on the number of worker at a particular skill levels (Lundgren and Cohen 1998), others have focused on researching about the discrepancy of demand and supply of workforce having a particular skill type (Holzer 2013).

Table 1 Skill mismatch defined according to various natures of skill data

Nature of skill data		Definitions
Quantitative	General	Any imbalance between the demand and the supply of skills (Manacorda and Petrongolo 1999, p.182)
		A quantitative shortage refers to a situation where labor demand is larger than labor supply (European Parliament 2015, p. 32)
		Mismatch between the skills supplied by college graduates and skills demanded by hiring industries (Liu et al. 2016, p. 2)
	Skill level	Mismatch between the skills in demand in the urban labor market and the skill levels of large numbers of the urban poor (Lundgren and Cohen 1998, p. 109)
	Skill type	Demand *for certain skills* exceeds the supply of such skills (Holzer 2013, p. 1)
Qualitative	General	The gap between the skills required on the job and those possessed by individuals (World Economic Forum's Global Agenda Council on Employment 2014, p. 7)
		Actual mismatch between acquired and required skills (Allen and Velden 2001, p. 436)
	Skill level	Situations in which workers' skills exceed or lag behind those employers seek (Handel 2003, p. 136)
		Situation in the labor market where the level of skills of individuals does not match the level of skills required in the jobs (EU Skills panorama 2017)
		When skills possessed by the workers exceed or do not meet the skills required at their workplace (Perry et al. 2014, p. 138)
		Actual match between a worker's skill proficiency and the level of skills required by the worker's job (Flisi et al. 2014, p. 1214)
	Skill type	Discrepancy between the skills – both specific and general – Possessed by a worker and the skills required by his/her job (OECD 2011a, p. 194)
	Skill level and/or type	A situation in which the level and/or type of skills and abilities of an individual is less or more than the required level of skills and abilities in the job (European Commission 2013, p. 14)
		Situation of imbalance in which the level or type of skills available does not correspond to labor market needs (Cedefop 2014, p. 231)
	Holistic	Either in terms of excess (over) or deficient (under) qualifications or skills possessed by individuals relative to job requirements (Cedefop 2012, p. 11)
		Constructed by comparing the skills (or qualifications) of an employed worker with the skill (or qualification) requirements of her job (Pellizzari and Fichen 2017, p. 4)
		A situation where there is a (qualitative) discrepancy between the qualifications and skills that individuals possess and those that are needed by the labor market (Cedefop 2015a, p. 27)

(*continued*)

Table 1 (continued)

Nature of skill data	Definitions
Qualitative + Quantitative	[it] does not only refer to imbalances between formal qualifications and required qualifications in work settings but also to discrepancies between skill demand and supply in a more holistic sense (Cedefop 2009, p. 5)
	[. . .] not only to skill shortages or gaps but also to qualifications, knowledge, and skills exceeding job requirements (Cedefop 2010b, p. 6)
	Skill mismatch refer to when the supply of skills and the demand for skills could be out of synch in either direction. . . A skill shortage is obviously of skill mismatch, and a skills gap could be a general form of mismatch (Cappelli 2015, pp. 252–253)

In contrast, researchers who view the concept of skills as work ability or competence have defined skill mismatch as the difference in the actual skills that are possessed by an individual and the skills required in a job (Allen and Velden 2001; World Economic Forum' s Global Agenda Council on Employment 2014). As mentioned previously, the dimension of skills includes levels, type, and its content; thus, some researchers focus on the mismatch in skill level (EU Skills panorama 2017; Flisi et al. 2014; Perry et al. 2014), while some focus on skill type (OECD 2011a), and others examine the mismatch of a more holistic concept of skills, which is encapsulated in qualifications (Cedefop 2012, 2015a; Pellizzari and Fichen 2017).

More recently, however, reports by institutions related to vocational education and training such as Cedefop have defined skill mismatch from a more integrated perspective, which includes both the number of workforce and the quality of the skill (Cappelli 2015; Cedefop 2009, 2010b). This implies that, in efforts to address skill mismatch globally, vocational education and training institutions have realized that studying about qualitative mismatch is as important as the quantity of desired skill workforce.

Scope of Skill Mismatches

These definitions have set some boundary or target area which describes the extent to which skill mismatches scope reaches, and this can be shown in Fig. 3. According to Cedefop (2010b), "skill mismatch is a complex phenomenon that affects citizens, enterprises, economies and societies." This implies that skill mismatch is a concept that could cover both a broad and narrow scope. Some literature reports on skill mismatches data which covers the wider labor market or international (Cedefop 2015b; European Commission 2013; Frogner 2002). As skills are an important capital for both the productivity of organization, skill mismatch concept also covers a narrower scope such as mismatch of skills of a group of workers in a firm and organization (Bennett and McGuinness 2009; Forth and Mason 2006;

Fig. 3 Scope of mismatch in skill mismatch definition

Jackson and Chapman 2012; McGuinness and Ortiz 2016). Also, it covers a more micro- (Bejaković and Mrnjavac 2014; European Commission 2013; Handel 2003) or individual level (Béduwé and Giret 2011; Kim et al. 2014; Mavromaras and McGuinness 2012; Mavromaras et al. 2015; McGuinness and Sloane 2011; Pouliakas and Russo 2015; Robst 2008; Sanchez-Sanchez and McGuiness 2015; Sloane 2014), which involves the mismatch between individual's skills and those which are required by the organization he is working in.

Type of Skill Mismatch

Skill mismatch types, in general, refer to both the inconsistencies in the supply and demand of workforce and any occurrence when skill at a particular level or type does not match. The types of skill mismatches investigated in previous studies can be summarized as shown in Table 2 and are categorized according to the scope of the mismatch. Skill mismatch types can vary depending on the topic, scope, and interests of the study.

The type of skill mismatch reported in various literatures include shortage of worker in firm (Forth and Mason 2006; Haskel and Martin 1996; Bennett and McGuinness 2009) or shortage of worker in a macro level (Frogner 2002; Cedefop 2015b; European Commission 2015).

Worker shortage, which views skills as workforce, occurs when the demand of manpower exceeds supply. For example, Bennett and McGuinness (2009) reported that worker shortage had a negative impact on firm-level performance. Cedefop (2015a) argues that there is a difference in worker shortage between European countries and has a negative effect on organizational productivity and performance.

Table 2 The type of skill mismatch according scope

Mismatch	Scope	Researcher
Shortage of worker	Firm	Forth and Mason (2006); Haskel and Martin (1996); Bennett and McGuinness (2009)
	Macro	Frogner (2002); Cedefop (2015b); European Commission (2015)
Overskilling	Micro	Béduwé and Giret (2011); McGuinness and Sloane (2011); Mavromaras and McGuinness (2012); Mavromaras et al. (2012); Sloane (2014); Kim et al. (2014); Mavromaras et al. (2015); Sanchez-Sanchez and McGuiness (2015)
	Macro	OECD (2011a); OECD (2015)
Underskilling	Micro	Béduwé and Giret (2011); Kim et al. (2014); Sanchez-Sanchez and McGuiness (2015); Pouliakas and Russo (2015)
	Firm	Jackson and Chapman (2012); McGuinness and Ortiz (2016)
	Macro	OECD (2011a); Cedefop (2015b); OECD (2015)
Horizontal mismatch (unmatched skill type)	Micro	Robst (2008); Béduwé and Giret (2011)
	Macro	Robert (2014); Montt (2015)

Overskilling and underskilling are another type of mismatch which defines skills according to the qualitative aspect and occurs when the required skill levels are above or below that is demanded, respectively. Much of the studies of overskilling are done at a more microlevel (Béduwé and Giret 2011; McGuinness and Sloane 2011; Mavromaras and McGuinness 2012; Mavromaras; Sloane 2014; Kim et al. 2014; Mavromaras et al. 2015; Sanchez-Sanchez and McGuiness 2015), while only regional institutions such as OECD had reported about overskilling from a macro perspective (OECD 2011a, 2015). In addition to micro- and macro scope of skill mismatch, studies of underskilling also occur at firm level (Jackson and Chapman 2012; McGuinness and Ortiz 2016). Furthermore, in some studies about over- and underskilling, when a particular skill level is unmatched, this is also called vertical mismatch (Béduwé and Giret 2011; McGuinness and Sloane 2011), and when the level is insufficient, this is referred as skill gap (McGuinness and Ortiz 2016).

Horizontal mismatch is a type of mismatch that occurs when a certain type of skill that is demanded is unmatched, and this includes specific type of skills that is encapsulated in a degree major (Robst 2008) or field of study (Béduwé and Giret 2011; Robert 2014).

Causes and Consequences of Skill Mismatch

Skill mismatch is caused by the imbalance between the supply and the demand of skills, and there are various causes in both skill supply and skill demand side that may contribute to this imbalance (Cedefop 2009; Handel 2003), which is influenced by various contextual factors, as shown in Fig. 4. The consequence of skill mismatch can be seen at various levels, including individual, firm, and macroeconomic, and affects factors such as individual wage, organizational commitment, and workforce unemployment rate (Cedefop 2009).

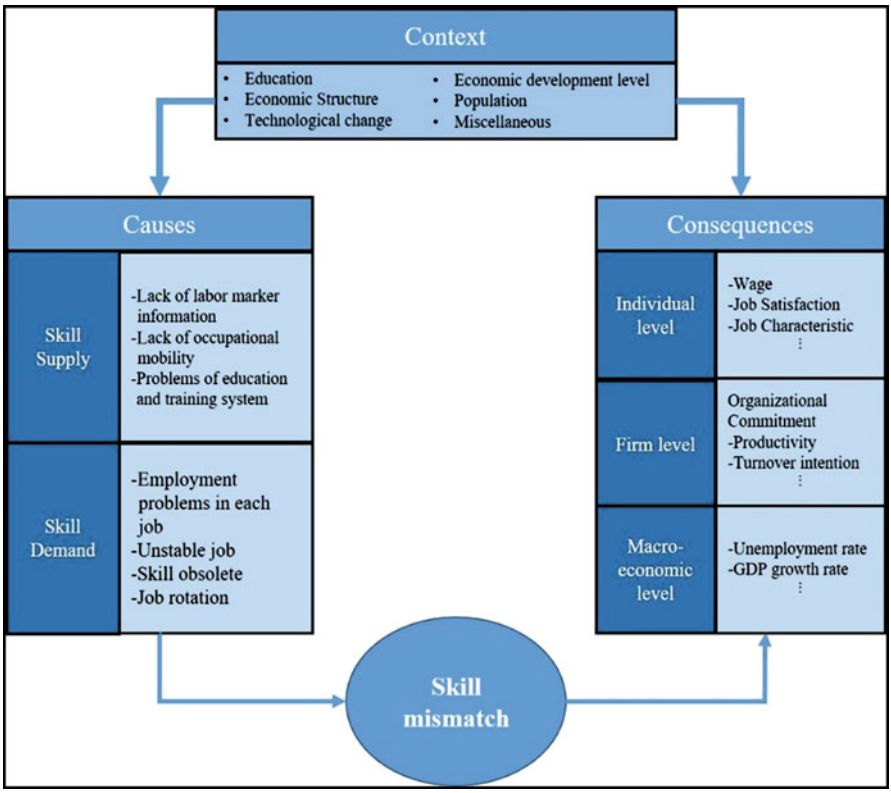

Fig. 4 Causes and consequences of skill mismatch

Contextual Factors

There are several contextual factors that can affect the outcome of skill mismatch including education (Kim et al. 2009), economic structure (European Commission 2013; Quintini 2011), technological change (European Commission 2013; ILO 2014; Perry et al. 2014), economic development level (European Commission 2013; ILO 2014), and population (European Commission 2013; ILO 2014; Perry et al. 2014). The European Commission (2013) found that skill mismatch is consistently influenced by coordination delays and market failures both as a result of complex interactions between skills demand and supply in the market economy and contextual factors. ILO (2014) classifies skill mismatch into two aspects according to skill acquisition and skill requirement and suggested that contextual factors such as economic level and structure, technological shifts, and institutional mechanisms influence skill mismatch. Perry et al. (2014) suggest that skill mismatch increases the demand of certain types of skills because skill change is generally skill-biased in terms of economic structural change, and it has been suggested that gender stereotyping in occupations affects skill mismatch. In addition to this, structural changes

such as the adoption of new technologies and the long-term unemployment rate (Quintini 2011), the phase of business cycle (Gambin et al. 2016; Quintini 2011), and the limits of college education (Kim et al. 2009) also influence skill mismatch.

Causes of Skill Mismatches

There are various drivers for generating a mismatch of skills according to several researchers and research institutes (Cedefop 2010b; Gambin et al. 2016; Handel 2003; Kim et al. 2009; MERCER 2011; Pavlovska 2014; Quintini 2011). These drivers, as shown in Fig. 4, can be divided into the supply and demand side of the skill.

In terms of skill supply, the causes of skill mismatch include incomplete information on the labor market (Cedefop 2010; MERCER 2011) and education and training system problems (Cedefop 2010; Gambin et al. 2016; MERCER 2011), inadequate investment in training and education (Gambin et al. 2016; Pavlovska 2014; OECD 2011a; Cedefop 2010), lack of intersectoral or interregional mobility (Gambin et al. 2016), lack of information on job seekers (Gamblin et al. 2016; Kim et al. 2009), incomplete career counseling and guidance (European Commission, 2013), and lack of preparation for job seekers. Quintini (2011) mentioned about the shifts in unstable job as a cause of skill mismatch, such as time and shift workers, while Pavlovska (2014) suggested that changes in responsibilities at work, the temporality of skills, and the increased demand for working speed were the causes of skill mismatch. The European Commission (2013) presented employment, vacant jobs, job to work, skill requirements and design, recruitment friction, and wage rigidity by division, vocational, and education. In addition, it is explained that when the skill becomes obsolete (Gambin et al. 2016; OECD 2011b, 2015), the skill level in the job and the skill level of the worker are inconsistent and mismatch arises.

Although the causes of skill mismatch are presented in various ways, it is a complicated problem that cannot be confined to either the supply side such as the problem of the education and training system or the demand side such as the employment problem. Therefore, when researching about skill mismatch, it is necessary to give an equal amount of attention to both causes in the demand side and the supply side of the system.

Consequences of Skill Mismatches

Effects of skill mismatch occurs at various levels including individual level, meso level, and macro level, as suggested by Cedefop (2009) report, while Mauries (2016) distinguishes the consequence of skill mismatch into two perspectives according to individual level, firm, and country level. The individual level mainly deals with the effects of skill mismatch on individual wages, job satisfaction, and job characteristics. Regardless of whether it is temporary or not, the skill mismatch has a negative effect on wages. Firm level mainly deals with the effect of skill mismatch on organizational commitment, productivity of company and organization employing

workers, and turnover intention. For instance, Lim et al. (2017) suggested that organizational commitment is lower where there is mismatch. Similarly, Feldman et al. (2002) suggested that organizational commitment decreases in skill over employment, underemployment, and incomplete employment. Furthermore, Pavlovska (2014) found that one-third of bankers experiencing skill mismatches caused instability and had a negative impact on work productivity. Cedefop (2009) also confirmed that the skill mismatch resulting from skill aging had a negative effect on the productivity of the company as well as underestimated skill. In the case of turnover intention, Cha and Chu (2010) confirmed that workers with overskills had a static effect of 1.5 times more on turnover intention than workers with appropriate skills showing that both the overskill and the underskill directly increase the turnover intentions. Due to the desire to find the right skill and job, the skill mismatch suggests a positive (+) effect on turnover intention (OECD 2012; Sloane 2014).

The macroeconomic level mainly deals with the effects of skill mismatch on the unemployment rate and GDP growth rate of the region or country. For example, Quintini (2011) suggested that the proportion of underskilled worker has a negative impact on the unemployment rate of the United States. Moreover, OECD (2009) concluded that the skill mismatch caused by oversupply of workers with a certain skill enhances unemployment.

This section has been derived from a review of the many studies about the causes and effects of skill mismatches or over education. These interest for an in-depth study about the causes and effects of overeducation and mismatches at individual and a more aggregate levels such as country level or regional level which had initially stemmed from early studies by Freeman in 1976. Freeman had analyzed educational mismatch in the United States between the 1960s to 1970, by examining the match between levels of education of college graduates, with the level of education required by the labor market. These studies were followed by more research of the same topic such as that by Duncan and Hoffman (1981).

Trends of Skill Mismatch Research

Although the interest about overeducation still perseveres to date, with the developments of databases such as PIAAC which enable skills to be measured skill directly, the concept of skill mismatch is now gaining more attention by policy-makers and researchers alike. The megatrends on skill mismatch were examined and presented as follows.

Firstly, in terms of regional perspective, by taking European Union countries as examples, there is a shift of focus from the quantitative to qualitative skill mismatch. Skill mismatches in the EU countries have been developed in a variety of ways according to skills-intensive nature of much economic and technological change (Cedefop 2009, 2010a). The study of skill mismatches in the EU has received renewed attention since the international economic crisis of 2008–2009 (Cedefop 2010a; Flisi et al. 2014). This is due to the deterioration of the labor market due to the slowdown in economic growth since the global economic crisis (Cedefop 2010a,

2014). In Europe, the study of skill mismatch has focused mainly on solving the structural divisions in the labor market and the labor supply and demand (Gregory 2015; Ryu 2014; Zimmer 2012). In recent years, however, studies on the effects of mismatch on labor market performance have been expanded according to the nature of vocational education and training. In addition, research on qualitative mismatches such as skill utilization and proficiency (Allen and Velden 2001; Bender and Heywood 2009) is increasing actively as well as skill mismatch research in terms of supply and demand of manpower.

Secondly, in terms of international organizations, strengthening of education and vocational training as a countermeasure for skill mismatch has been gaining more attention. As part of its international efforts, international organizations have been constantly engaged in discussions to maximize the effectiveness of policy interventions, human resource deployment, and utilization to resolve supply-demand disparities in the labor market and to balance the supply and demand of human resources (McGuinness et al. 2017; OECD 2005).

Since the 1990s, large-scale panel data has been developed as a response to the increasing interest in studying about skill mismatch internationally or nationally. Internationally, the system which provides strong links between education and training and labor market, such as vocational education, has been identified as a tool to address and prevent skill mismatch (The World Economic Forum 2014). These tools however need to be supplied with correct information about labor market, and hence the skill outlook and skill strategy have been discussed recently on how to predict future skill needs. Furthermore, in cases where skill mismatch has already occurred due to the lack of quality education and training system, efforts to mitigate or "treat" these skill mismatch have also been considered (ILO 2014).

Within individual countries, research institutions and governments are no longer focusing on examining the distribution of skill mismatch and their causes and consequences that affect their country. Rather, they have shifted to focus more on international comparisons of skill mismatch situation with other countries to identify the weakness in their own systems or to benchmark other systems. Research trends for skill mismatch at individual country levels vary from country to country depending on the region, especially economic development level. In regions where data on the labor market are relatively structured, such as advanced countries like the United States, Australia, and Canada, data or policy efforts have been developed for a relatively long period of time. Moreover, they have developed their own panel data from the 1970s and have been actively conducting research on skill mismatch measurement using databases on employment and the labor market. Since then OECD has been working on large panel data to collect information about skills in OECD countries. On the other hand, in developing countries or non-OECD countries, systematic research to measure skill mismatches in countries and specific regions (Marelli et al. 2014) has been actively conducted only recently by constructing panel data while comparative researches are also increasing.

The megatrend on skill mismatch topic shows a shift from just debates and literatures about policies on a macro level to the diversification in research topics to include studies about causes and consequence of skill mismatch and various other

discussions that arise through comparative analysis studies. Skill mismatch has begun to be studied as a labor market problem related to employment, whereby unemployment rate is identified to be the cause for skill mismatch and various human resource policies were discussed in relation to this (Greehalgh 1999). Since the 1990s, the research on skill mismatch have been steadily growing and diversified. The study of the causes and consequences of skill mismatches was conducted, and the drivers of skill mismatch including gender (Cedefop 2010b) and ethnicity (Cedefop 2010b) were discussed, while the effects of the skill mismatch are mainly discussed in terms of wage (Bárcena-Martín et al. 2012), job satisfaction, and turnover intentions (Béduwé and Giret 2011). There was also a study on the comparison between countries (OECD 2011a, 2015; Cedefop 2015b; Quintini 2011).

Research methods of skill mismatch have also shifted greatly from only a focus on review of literature and concepts of the skill mismatch phenomenon to include more empirical studies using a wide variety of data as mentioned in the measurement section of this chapter. Skill mismatches have begun with related research on the concept and phenomenon (Murphy 1985). Survey research was conducted to analyze the phenomenon of skill mismatch using large-scale survey data at national level (Cedefop 2015b; Mont 2015; OECD 2011a, 2015) and surveys by individual researchers (Sgobbi and Suleman 2013). Survey initially used proxy values such as education level and changed to measuring specific skills such as skill level, type, and utilization. In recent years, survey data that measures more direct skills such as literacy and numeracy have also emerged.

Conclusion and Implication

Until now the understanding of skills and the researches of skill mismatches have undergone significant developments. In the past, studies of skills and skill mismatch have used indirect proxies such as level of education or qualification. However, due to the availability and developments of databases and surveys which offer direct measurement of skills such as PIAAC, skill mismatches are now entering a new stage whereby the actual skills could be collected rather than using less informative proxies. Despite such developments, there is still room for more contribution to the debate about concepts of skills, its dynamic processes, and its consequence. In this chapter, we do not propose a clear-cut definition of skills and skill mismatches. This is because all the definitions and concepts provided in past literatures have their own importance and emphasis and have been used according to different purposes and context. Rather, we suggest that skills and its mismatches could also include a more holistic perspective and can be viewed through a multidimensional lens.

As the detrimental effects of skill mismatches reach all levels from individual to firm and organizational, country and globally, policies or ways to alleviate these effects should be addressed more seriously. Vocational education and training, as well as workforce development, are one of the tools for the *prevention and treatment* of effects of skill mismatches. Vocational education and its curriculums, which are systematically informed about the prospects of skills needed by employers, can play

Table 3 Skill types by institutions and researchers

Common skill type		ILO		UNESCO	US	
		Brewer and Coryn (2015) analysis of six countries	Stoevska (2015) generic type	UNESCO (2014)	CareerOneStop (2017)	O*NET (2017)
Core skills	**Basic skills**	**Basic or foundational skills** - Literacy - Numeracy	**Basic skills** - Writing and reading skills - Numeracy	**Foundation skill** - Basic academic knowledge - Literacy - Numeracy	**Academic competencies** - Reading - Writing - Mathematics - Science - Communication (listening and speaking) - Critical and analytic thinking - Basic computer skills	**Basic skills** - Reading comprehension - Active listening - Writing - Speaking - Mathematics - Science - Critical thinking - Active learning - Learning strategies - Monitoring
	Personal or professional skills	**Professional or personal skills** - Honesty, integrity - Work ethic	**Generic/ transferable/ soft portable skills** - Professional and personal skills (punctuality, honesty, reliability, dependability, self-organization, teamwork)	**Transversal skills** - Interpersonal skills (e.g., presentation and communication, organizational skills, teamwork) - Intrapersonal skills (self-discipline, enthusiasm, perseverance, self-motivation)	**Personal effectiveness competencies** - Interpersonal competencies - Integrity - Personal acceptability - Initiative - Dependability and reliability - Lifelong learning	**Cross-functional skills** - Social skills
	Other core skills	**Core work skills** - The abilities to learn and adapt - *To think creatively* - *To solve problems independently* - To read, write, and compute competently - To listen and communicate effectively - To manage oneself at	**Generic/ transferable/ soft portable skills** - *Problem-solving skills* - Decision-making skills - Communication skills - ICT skills	**Transversal skills** -Global citizenship (respect for diversity) - Media and information literacy	**Workplace competencies** - *Creative thinking and problem-solving* - Business fundamentals - Teamwork - Adaptability and flexibility - Marketing and customer focus - Scheduling and coordinating - Checking and examining and recording	**Cross-functional skills** - *Complex problem-solving skills* - *Systems skills* - *Resource management skills* - *Technical skills*

				Singapore	Australia	Korea
Casner-Lotto and Barrington (2006)	O'Neil et al. (1992)	SCANS (1991)	ACT WorkKeys (2015)	Workforce skills qualifications (2017)	Curtis and McKenzie (2001)	Na et al. (2003)
Basic knowledge skills - Speaking - Reading - Writing - Mathematics - Science - Economy - Foreign language	**Basic skills** - Reading - Writing - Computation - Arithmetic - Communication skills - Academic skills	**Basic skills** - Reading - Writing - Mathematics - Listening - Speaking	**- Reading and using work-related text** **- Applying mathematical reasoning to work-related problems**	**Foundational competencies**	**Basic skills** - Thinking skills - Contextual understanding - Organizational skills	**Basic competencies** - Literacy - Numeracy - Communication skills
Applied skills - Teamwork/ collaboration - Diversity - Lifelong learning/self-direction - Professionalism/ work ethic - Ethics/ social responsibility	**Personal characteristics and attitudes** - Responsibility - Self-esteem, Self-management - Integrity - Personal work habits **Interpersonal and teamwork skills** - Serves customers, - Works with diversity - Leadership - Teamwork, organizational structure - Interact socially	**Personal qualities** - Responsibility - Self-esteem - Sociability - Self management - Integrity/ honesty - **Interpersonal**		**Cross-cutting competencies**	**Personal attributes** - Continuous learning - Personal attributes - Interpersonal skills	**Basic competencies** - Interpersonal skills - Self-development
Applied skills - *Critical thinking/ problem-solving,* - *Creativity/ innovation* - Oral communications - Written communications - *Information technology application* - Leadership	**Higher-order thinking skills** - *Creative thinking* - *Decision-making* - *Problem-solving* - *Reasoning* - Drawing conclusion - Etc.	**Thinking skills** - *Creative thinking* - *Decision-making* - *Problem-solving* - Knowing how to learn - Reasoning *Resources, information, literacy systems technology*	- *Problem-solving* - *Critical thinking* - *Information literacy* **- Comparing, summarizing, and analyzing information** -		**Intellectual abilities** - *Thinking Skills* - Contextual understanding (understand interrelationship in work process and systems) - Organizational skills (resource management, coordinate task, etc.	**Basic competencies** - *Problem-solving* - Information organizational skills - Business/ management skills - Physical ability - Technical skills

(*continued*)

Table 3 (continued)

Common skill type		ILO		UNESCO	US	
		Brewer and Coryn (2015) analysis of six countries	Stoevska (2015) generic type	UNESCO (2014)	CareerOneStop (2017)	O*NET (2017)
		work - To interact with co-workers - To work in teams or groups - *To handle basic technology* - To lead effectively, as well as follow supervision			- *Working with tools and technology*	
Industry Specific Skills					**- Industry-wide technical competencies** **- Industry-sector technical competencies**	-
Occupation Specific Skills		**Vocational/ technical skills** - Specialized skills, - knowledge or know-how needed to perform specific duties or tasks	**Job-specific skills/ technical skills** - Specialist knowledge needed to perform job duties - Knowledge of particular products or services produced - Ability of operating specialized technical tools and machinery - Knowledge of materials worked on	**Specialized skills** - Specific "know-how" needed for a fulfilling and meaningful life and decent employment	**- Occupation-specific requirements** **- Management competencies**	–

				Singapore	Australia	Korea
Casner-Lotto and Barrington (2006)	O'Neil et al. (1992)	SCANS (1991)	ACT WorkKeys (2015)	Workforce skills qualifications (2017)	Curtis and McKenzie (2001)	Na et al. (2003)
				Industry competencies		**Common industrial competencies**
				Occupational competencies		**Work performance competency** (which also includes *common industrial competency, mandatory competency, and optional competency*)

a role in delivering the required supply of skilled worker that is demanded by the labor market and thus prevent skill mismatch at initial stage of employment. On the "treatment" aspect, skill mismatches that arise due to the lack of specific skills can be alleviated by developing vocational training which facilitates the upskilling of workers or jobseekers in a targeted skill. A continuous workforce development is especially important for employees to upgrade their skill and keep up with the constantly changing demands of the labor market. However, all of these would not be possible without a proper labor market information system which constantly feeds information about current situation on skills to these vocational education and training and workforce institutions.

Appendix 1: Common Skill Types by Institutions and Researchers

See Table 3.

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