11 Responding to technological change by promoting learning and skills upgrading in the economy

In Article 9 of this Annual Reflection, *Strengthening technological capability*, two important sub-systems at the meso level are mentioned. The two sub-systems are made up of the technological institutions that disseminate codified and tacit knowledge (through technological services) and the education institutions that mainly disseminate formal and structured knowledge in the form of teaching and research.

In our experience of diagnosing and improving innovation systems, both of these sub-systems are important in upgrading the skills and use of knowledge in the economy, but offer different pathways for companies to upgrade. When considering how economies can learn to cope with or even make use of discontinuous technological change, the different roles of these two sub-systems are very important.

Two pathways for upgrading companies and industries

Education is important for individuals, and is a prerequisite in many occupations. There is a strong correlation between levels of education and the ability to learn more difficult material, also called the absorptive capacity of an individual. However, it not just the absorptive capacity of a person that is important, but also the authority and means to enact new knowledge. For instance, a well-educated person stuck at a level in an organisational hierarchy where they do not have the authority to act upon their insight may be powerless.

The ability of an organisation to leverage the absorptive capacity of individuals can be seen as the absorptive capacity of the organisation. To come back to the example above, in the case of a person who cannot act on their insight, the absorptive capacity of the organisation undermines the absorptive capacity of the individual. This implies that if an organisational hierarchy is not able to draw on the expertise and insight of the workforce, then the capacity of the organisation to act on absorbed knowledge is limited, despite the presence of individuals or teams with high levels of absorptive capacity.

Hence a first pathway to change an organisation is for leadership to encourage individuals to act upon what they know or have learned. In this way, individuals change the organisation as they learn new things. This is how top-down change mandated by management and bottom-up change through individual learning can complement each other. Thus absorptive capacity in organisations is as much about culture and leadership capability as it is about the education of the workforce.

However, changing an organisation through educating the existing workforce can take a long time. A second pathway to upgrade organisations that usually happens faster lies in working with technological institutions that provide technological extension, knowledge-intensive services, etc. to companies. For instance, the implementation of a management system such as ISO 9001 will upgrade the many procedures and management systems in a company, regardless of the levels of education of its workforce and the strategic abilities of its leaders. Pressure from a demanding client requesting a particular kind of certification, such as ISO 9001, can override the hesitations or inadequacies of management. This also applies to other kinds of knowledge-intensive support received from technological institutions. For instance, if the management of the organisation decides to approach a technology transfer or research centre for assistance with a technological problem, the advice, if accepted, will be implemented in a top-down way. This might

even happen if management does not fully u
the technicalities or the science behind the s
Besides upgrading systems and processes in t
company, these changes also enhance the absor
capacity of the organisation despite the levels of
education and capacity of the management not
changing.

These two pathways ideally happen in parallel and complement each other. However, basic education, and especially technical secondary schooling, is still very important, as it lays the foundation for individuals to absorb knowledge.

When technological change requires fundamentally new competences

In Article 8 of the 2018 Annual Reflection, *Looking at discontinuous change through a Systemic Competitiveness lens*, two kinds of technological change were identified:

- Competence-enhancing technological change. Current users of a particular technology are able to build on previous experience, qualifications and knowledge. The change could be incremental or radical, but the old technological domain and its know-how are not entirely lost but are sustained.
- Competence-destroying technological change. Here, past experience, qualifications and knowledge are made obsolete by new technologies that require a very different skill set and often mindset to operate. Furthermore, these technologies may be dependent on other sub-systems, meaning that this change may also have knock-on effects in other areas in the organisation or industry.

The importance of workplace learning and further education is especially important when disruptive technological change is competence enhancing, as individuals are able to master new technologies that complement or even leverage what they already know.

The story is different when technological change is competence destroying. In this case, the education and experience of the workforce does not prepare them for the future, either because they lack the right experience and knowledge, or because their jobs become completely redundant due to the change. In this case, the workers affected must quickly be retrained or replaced. This is not easy, because re-education is often hampered in many developing countries due to insufficient social security covering the time needed to re-train or a lack of flexible education

options. It takes years to get a new qualification, and often this path is chosen too late.

This kind of re-skilling often does not take place at workplaces, even when imminent technological change is evident. In South Africa, large corporates that retrench workers often send affected workers on entrepreneurship training, but this hardly results in the formation of successful new enterprises. It only adds to the numbers of self-employed or informal enterprises that are based on necessity and not choice.

This means that to prepare developing countries for disruptive technological change, attention must be given to both the absorptive capacity of individuals and organisations and to building the system for re-training and further education.

Supporting meso institutions

From a development perspective, focusing on strengthening the technological institutions in a developing country could provide a more leveraged approach

to upgrading industries and organisations despite education levels. It is thereby important to understand that these institutions themselves are structurally and economically challenged by discontinuous technological change. Increasingly, think tanks, intermediaries and NGOs are playing a role in helping the education system to respond to change, to prepare workers for new careers, or to assist the youth to figure out how to choose and pursue a particular path. Development programmes need to take this into account and work with all possible institutions that are in the system they work, rather than to work with the assumption that public organisations are the only ones that can deliver meso-level functions to support technological development.

At the same time, education still has a huge role to play. More system innovation is needed to detect competences that may be destroyed, or capabilities that must be further developed. Ways must be found to rapidly re-educate people who are trapped in occupations that may be threatened due to technological change. This education must be comprehensive, and entry requirements must be sufficiently low but of sufficient quality to ensure that people can master new skills, knowledge and worldview. It is also important that this education should be widely accessible, both in terms of course times but also geographically so that the rural unemployed can have access to alternative pathways.

This means that both kinds of institution, technological as well as educational, must receive attention. Ideally, a diverse range of pathways for individuals, teams and organisations should exist.

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