Exploring technology attitudes and personal–cultural orientations as student readiness factors for digitalised work

Todd J.B. Blayone
Educational Informatics Lab, Ontario Tech University, Oshawa, Canada
Olena Mykhailenko
Collaboritsi.com, Oshawa, Canada
Svetlana Usca
Research Institute for Regional Studies, Rēzekne Academy of Technologies, Rēzekne, Latvia
Anda Abuze
Faculty of Engineering, Rēzekne Academy of Technologies, Rēzekne, Latvia
Ihor Romanets
Educational and Scientific Centre of Information Technologies, Ternopil National Economic University, Ternopil, Ukraine, and
Mykhailo Oleksiiv
University Computer Training Laboratory, Ternopil National Economic University, Ternopil, Ukraine

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Abstract

Purpose – Emerging forms of digitalisation are placing new demands on workforce entrants around the globe. This study, catalysed by innovation programs in Ukraine and Latvia, conceptualises, measures and compares key facets of dispositional readiness of university students in two post-Soviet nations for digitalised work.

Design/methodology/approach – Survey data, addressing technology attitudes and personal–cultural orientations (PCO), were collected by project teams at universities in Ukraine and Latvia and delivered to the authors for analysis. The authors defined three characteristics of digitalised work, conceptually positioned five of the measured constructs as readiness factors and generated readiness profiles for the two national student cohorts. Investigation of significant differences between the groups was conducted using an Independent Samples *T*-Test. A composite profile was produced for comparing the overall dispositional readiness of both groups for digitalised work.

Findings – The factor-level profiles showed similar patterns of dispositional alignment and misalignment with digitalised work. For example, technology optimism and learning interest were reported by large percentages of Ukrainians and Latvians and tolerance for unstructured work by small percentages. However, significant differences were found in group levels of technology optimism, technology anxiety, ambiguity intolerance and empowered decision-making. In each case, the Ukrainian profile appeared more strongly aligned with the target.

Practical implications – The global digitalisation of work requires students, educators, human resource professionals and business leaders to rethink workforce readiness assessment and adapt (re)training

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programs. Technology enthusiasm and learning interest should be regarded as crucial measurable attitudes motivating technical skills development. Also, cultural orientations should be positioned alongside personality traits and digital skills as factors shaping successful human–computer interaction.

Originality/value – This study initiates a new sociotechnical and cross-cultural trajectory of technology readiness research from data generated in two post-Soviet contexts. Moreover, it positions several measurable dispositions as factors influencing student readiness for digitalised work.

Keywords Workforce readiness, Readiness for digitalised work, Technology attitudes, Information technology, Cultural orientations, Latvia, Ukraine

Paper type Research paper

Introduction

Preparing university students for success in emerging sociotechnical environments is a global concern. "Digitalised work" describes professional activity incorporating technological innovations such as machine learning, Internet of things, big data, collaborative robots, smart sensors, 3D printing and advanced interfaces among others (Geissbauer *et al.*, 2015; Rüßmann *et al.*, 2015). These technologies are increasingly being deployed across market sectors to increase system intelligence, strengthen human–machine interaction, meet sustainability targets and improve outputs (Balsmeier and Woerter, 2019; Fielke *et al.*, 2019; Xu *et al.*, 2018). Indeed, a global effort to address the COVID-19 pandemic appears to be accelerating digitalisation in the health sector (Javaid *et al.*, 2020).

Digitalised work extends beyond computers and mobile devices to virtual and augmented reality setups (Choi *et al.*, 2015), health monitoring sensors (Kaare and Otto, 2015), brain–computer interfaces (Hancock *et al.*, 2013), speech recognition and computer vision (Zhong *et al.*, 2017), dynamic augmentation (Romero *et al.*, 2016) and hybrid teaming (Richert, 2018). Formerly the stuff of science fiction and digitalisation is driven by transnational programs like Industry 4.0 (Xu *et al.*, 2018) and Society 5.0 (Fukuda, 2019). An emerging challenge for technology readiness researchers, therefore, is to explore the defining qualities of digitalised work and the new demands they place on workforce entrants. To date, there have been only scattered and early-stage responses to this challenge (Blayone and VanOostveen, 2020). Moreover, there is little agreement as to what domains the investigation of human readiness for digitalised work properly belongs (Murawski and Bick, 2017).

This study addresses this research gap by shifting the target activity from traditional forms of computer-mediated activity to digitalised work as envisioned by Industry 4.0. A critical insight is that although Industry 4.0 is a manufacturing-based discourse (Fonseca, 2018; Ghobakhloo, 2018), it showcases technologies and human–computer interaction scenarios relevant to digitalisation in other key sectors (e.g. education, retail and healthcare). Second, this study draws attention to less researched dispositional factors influencing worker readiness. On this point, digitalised environments, which increase human–machine intimacy and exhibit high levels of structural dynamism, are expected to place new social, cognitive and emotional demands on workers (Blayone and vanOostveen, 2020).

A staged, emergent strategy was adopted to address the logistical demands placed on participating research teams in participating countries (Hesse-Biber and Leavy, 2008). In the first stage, four survey data sets, addressing technology-related attitudes and PCO, were collected at participating universities in Ukraine and Latvia by associates of the sponsoring projects. In the second stage, the designated authors (1) formulated their specific research questions, (2) modelled key characteristics of the target activity and reduced the data set accordingly to a manageable set of readiness factors and (3) conducted quantitative analyses to produce, compare and interpret the dispositional profiles of the two national student groups. Before detailing this strategy, presenting the guiding research questions and reviewing key findings, the contexts of study are addressed.

Contextual rationale and highlights

This study was catalysed by two development initiatives funded by the governments of Ukraine and Latvia addressing the preparedness of university students for the future of work (with a focus on technology, gender and culture). Ukraine and Latvia are under-researched contexts well positioned to address the call from some Western social scientists for more culturally diverse research (Arnett, 2008). As a pair, these nations share a highly formative Soviet experience that shaped their educational institutions and cultural values (Hofstede, 2001). However, they also display many distinct features owing to differences in history, geography, religion, language and current levels of EU integration.

Both countries achieved independence following the dissolution of the Soviet Union in 1991. Ukraine, a country of 44 million people (Central Intelligence Agency, 2020b), was a Soviet republic for almost 70 years. It has advanced through two peoples' revolutions—the Orange Revolution in 2004 and the Revolution of Dignity in 2014—each catalysing institutional reform and infrastructural development. Latvia, a country of 1.9 million people (Central Intelligence Agency, 2020a), was a Soviet republic for 45 years. Its post-Soviet development has been less tumultuous, and it is now an EU member state.

Addressing the general technology readiness of people in these nations, The Social Progress Imperative (2019a, b) finds the highest levels of adult-literacy and mobile phone subscriptions by global standards. Also, Latvia is ranked 29th in the world with 82% of its population having Internet access, while Ukraine is ranked 74th with slightly less than 60% access. Digital-competency assessments of citizens are available via the International Telecommunications Union's (ITU) *Information Society Report* (2018), which shows large segments of the Latvian population possessing basic digital skills. Advanced skills, however, appear far less developed as is the trend in many EU nations. Although Ukraine is not represented in the ITU data set, two recent studies measured the digital competencies of university students in this country. Findings showed a wide distribution of basic competencies and a narrow distribution of advanced competencies such as those involving information management, data analysis and scripting/programming (Blayone *et al.*, 2018a, c). Although nation-level data addressing technology-related attitudes are rare, the World Values Survey asked respondents if "more emphasis on technology in everyday life would be a good thing" (Institute for Comparative Survey Research, 2019). Within Ukraine, over 70% selected the most enthusiastic response. Data for Latvia are not available, but respondents from Estonia (Latvia's Baltic neighbour) were somewhat less enthusiastic with 59% responding most positively.

Finally, a few notes about the information technology (IT) sectors and the digitalisation of work in Ukraine and Latvia are in order. Significant growth in Ukraine's IT sector has been reported in recent years, with tech exports now dwarfing even Ukraine's wheat exports and amounting to 3.63 billion in 2019 (Kossov, 2020). Although Latvia has a relatively small share of high-tech products in total exports and a shortage of skilled workers, the IT sector is also developing rapidly (Menaker and Ozoliņa, 2018). The digitalisation of manufacturing, government and other sectors is an economic-development concern in both countries, with Ukraine drawing upon a tradition of technology-focused higher education and Latvia benefiting from its position as an EU member state (Kyiv International Economic Forum, 2016; Organisation for Economic Cooperation and Development, 2018).

In the end, despite socioeconomic challenges shared by many post-Soviet states, both Ukraine and Latvia are showing momentum towards full participation in global processes of digitalisation, which includes a shared focus on higher education reforms strongly aligned with workplace competency requirements (Huisman *et al.*, 2019).

Literature review

Readiness research has roots in learning psychology and technology-system development (Sullivan, 1970; Thorndike, 1932). At the micro-level of individuals and groups, readiness

researchers theorise and measure characteristics of people (*factors*) in relation to a *target* activity (F…T). Factors typically address sets of knowledge, skills and dispositions considered relevant to the target and which individuals can develop or learn (Blayone, 2018). The target activity may address established technologies and work processes, or it may encompass emerging forms of professional activity such as those introduced through digitalisation.

Over the past decade, researchers working in the e-readiness and digital-skills subdomains have ably deployed observational procedures and survey instruments for investigating human interactions with computers, mobile devices and online resources in educational, work and personal contexts (Alaaraj and Ibrahim, 2014; Eshet, 2012; Litt, 2013; Van Deursen and van Diepen, 2013). However, this previous research focuses on traditional technology-use scenarios in which humans interact with consumer devices running mainstream software applications (Eshet, 2012; Hargittai and Hsieh, 2012; Van Deursen *et al.*, 2016). Also, and as a consequence of this orientation, humans are positioned as agential operators and computational devices as responsive tools (Grudin, 2017). This framing becomes problematic, however, as (1) computational functionality extends to objects and systems of many kinds; (2) machines gain sensory, cognitive and physical capacities formerly available only to humans and (3) human–machine interfaces diversify, incorporate natural language processing capabilities and connect directly to human physiological systems (Franklin, 2014; Romero *et al.*, 2016). These are precisely the kinds of transformations that characterise *digitalised work*. There are a few signs that digital-skills researchers are adjusting to the challenges of ubiquitous computing and smart technologies (van Deursen and Mossberger, 2018). However, one must look elsewhere to find fuller engagement with digitalisation as a novel socio-technical paradigm requiring well-aligned worker competencies.

Fuelled by international programs like Industry 4.0, researchers in the areas of information systems, business management and various cognate disciplines have begun developing conceptual models addressing readiness for digitalised work. Introduced at the 2011 Hannover trade show in Germany (Ghobakhloo, 2018), Industry 4.0 has become a global discourse driving innovation in manufacturing and other market sectors, reenvisioning relationships between human actors, physical objects, intelligent systems, big data streams and decision-making processes (Khaitan and McCalley, 2015; Muhuri *et al.*, 2019). Consequently, Industry 4.0 instigates major workforce transformations as humans and machines are brought into closer proximity as dynamic collaborators across physical, cognitive and sensorial dimensions (Vaidyaa *et al.*, 2018). Workforce-focused Industry 4.0 readiness models tend to emphasise three major factor clusters: (1) social and collaboration competencies (Dworschak and Zaiser, 2014; Erol *et al.*, 2016; Gehrke *et al.*, 2015); (2) technical knowledge, skills and attitudes (Galaske *et al.*, 2017; Hecklau *et al.*, 2016; Mourtzis, 2018) and (3) positive attitudes and mindsets towards learning and workplace dynamism (Adolph *et al.*, 2014; Erol *et al.*, 2016; Hecklau *et al.*, 2016). Less prominent factors include intrapersonal and intercultural skills (Hecklau *et al.*, 2016; Mittelmann, 2018). These models, however, tend to be early-stage proposals based on small-scale literature reviews (Blayone and vanOostveen, 2020).

Beyond the digital-skills and Industry 4.0 research streams, which generally do not intersect, a vast and diverse body of social psychological research addresses various attitudes towards computers, the Internet and mobile devices (Cai *et al.*, 2017; Dwivedi *et al.*, 2017). Several systematic reviews have organised portions of this research from different theoretical and domain-specific perspectives (Cai *et al.*, 2017; Dwivedi *et al.*, 2017; Huscroft-D'Angelo *et al.*, 2019; Marangunić and Granić, 2014; Moos and Azevedo, 2009). Overall, owing to the theoretical and methodological eclecticism of this literature, it is very challenging to systematise, and some have proposed meta-analytical frameworks to encourage greater conceptual standardisation going forward (Tate *et al.*, 2015).

It is noteworthy that within this literature, one finds a research stream led by Scottish researchers addressing the dispositions of Eastern European academics towards computing, the Internet and engineering (Durndell *et al.*, 1997, 2000; Durndell and Haagb, 2002; Durndell and Thomson, 1997). Although somewhat dated, two key findings may be noted. First, Eastern Europe was producing proportionally far more female technologists, engineers and physicists than Western Europe (Durndell and Haagb, 2002). Second, many respondents reported high levels of computer anxiety, unfavourable attitudes towards technology and low computer self-efficacy, mirroring some Western findings from the same period (Cai *et al.*, 2017).

In the end, owing to the emergent nature of digitalised work and the early-stage orientation of existing workforce-level readiness research, this study treads new ground. The following (logically progressive) research questions were posed to investigate the dispositions of university students in two post-Soviet European nations towards digitalised work:

(1) What are the defining characteristics of digitalised work as theorised in the Industry 4.0 literature? (RQ1)

(2) Of the measured dispositions, which are most relevant as potential worker readiness factors? (RQ2)

(3) What are the factor profiles of Ukrainian and Latvian respondents (for the selected factors), and are there significant differences between these national groups? (RQ3)

(4) In what ways are the composite dispositional profiles for each national group aligned or misaligned with the theorised requirements of digitalised work? (RQ4)

RQ1 and RQ2 are foundational, and consequently, they were addressed as conceptual tooling exercises reported below as brief methodological excurses. The primary research questions, RQ3 and RQ4, are addressed via quantitative analyses and presented in the results section. Responses to the full set of research questions are summarised and consolidated in the discussion section.

Methodology: apparatuses and procedures

The emergent research design, described below, reflects the logistics of gathering data in two nations according to the requirements (schedules and guidelines) of the government-sponsored projects. Two survey instruments (described below as Apparatus A and B) were selected and administrated by participating project teams before the involvement of the lead author. Once the data were collected and delivered for analysis, the project scope and accompanying research design was developed.

Apparatus A: personal–cultural orientations

The personal–cultural orientations (PCO) model (Sharma, 2009) synthesises an established nation-level framework (Hofstede, 2001) with social psychological findings addressing the same constructs at the individual level (Oyserman, 2006; Oyserman *et al.*, 2002). In this way, Sharma (2009) derives ten distinct orientations from five nation-level constructs, as summarised in Table 1. Although rooted in the work of Hofstede (2011), which was developed by surveying the values of IBM employees from 72 countries, the PCO model extends the operational scope beyond corporate contexts and emphasises both culture and personality as determiners of individual values. The accompanying instrument (PCO scale) deployed for data collection in this study is a 40-item questionnaire measuring the ten orientations on a seven-point Likert scale of agreement (Sharma, 2009) [1].

	Factors	Derivation	Description of orientation
1	Independence (IND)	*Individualism,* addressing the problem of self-concept and the responsibilities felt by individuals towards the collective, is the degree to which individuals focus on looking after themselves	A strong sense of independence, autonomy, personal freedom and achievement
2	Interdependence (INT)		A group identity/belonging, a responsibility to others within a social circle, and a focus on addressing shared goals
3	Power (POW)	*Power distance,* addressing the social problem of inequality, is the degree to which less powerful members of an organisation or institution accept unequal distributions of decision-making power	The degree to which individuals accept hierarchically structured power and decision-making in businesses and organisations
4	Social inequality (IEQ)		The degree to which people tolerate differences in social status and equality
5	Risk aversion (RSK)	*Uncertainty avoidance,* addressing intolerance for ambiguity, is the degree to which people feel uncomfortable with ill-defined problems and novel situations	Addressing the degree to which individuals seek to avoid risky situations and decisions
6	Ambiguity intolerance (AMB)		Addressing the degree to which individuals lack tolerance for unstructured, open-ended and emergent tasks, activities and situations
7	Masculinity (MAS)	*Masculinity*, addressing dynamics of interaction and exchange between members of society, is the degree to which members are comfortable with competition versus nurturing	Associated with strong expressions of assertiveness, aggression, competitiveness and ambition
8	Gender equality (GEQ)		Addressing perceptions of men and women as equal regarding roles, capabilities, rights and responsibilities
9	Tradition (TRD)	*Long-term orientation*, addressing general living strategies, is the degree to which people focus on immediate needs versus longer-term investments	Associated with "traditional values" including respect for family and cultural heritage
10	Prudence (PRD)		Associated with long-term planning, hard work, sacrificing gratifications for future benefits and resilience

Table 1.
Overview of measured personal–cultural orientations

Apparatus B: attitudes towards information technology

Five attitudes towards information technology (IT) were organised by American scholars to study worker shortages and gender differences in IT programs and workplaces (Gokhale *et al.*, 2013). The foundation for this model is Allport's (1935) definition of attitudes as mental states of readiness developed over time, which influence an individual's response to related objects and situations (Gokhale *et al.*, 2013). The five attitudinal complexes defined and operationalised by this Attitudes Toward Information Technology (A-IT) model are shown in Table 2. Pursuing a gender-related subtext, the A-IT ignores self-efficacy constructs because they are popular in the technology readiness research (Litt, 2013) and generally equally distributed among males and females (Cai *et al.*, 2017). The accompanying instrument (A-IT scale) deployed for data collection in this study is a 30-item questionnaire measuring five attitudes on a five-point Likert scale of agreement (Gokhale *et al.*, 2013) [2].

Apparatus C: target activity model

A three-facet target activity model, addressing RQ1 and summarised below, was developed from data generated for an integrative literature review addressing workforce readiness for Industry 4.0 (Blayone and vanOostveen, 2020). It is noteworthy that the precise

characteristics of digitalised work will be shaped by sector-specific requirements, chosen technology systems, levels of automation, organisational cultures and individual differences (Fischer and Pöhler, 2018). However, as described by Industry 4.0 (Xu *et al.*, 2018) and Society 5.0 (Fukuda, 2019), digitalised work represents an identifiable constellation of technologies and practices that shape human–machine interaction, activity dynamics and human readiness requirements in predictable ways. For the purposes of this study, three major characteristics of digitalised work activity are foregrounded.

The first addresses the positioning of computational machines as intelligent agents capable of goal-directed action, autonomous decision-making, situational adaptiveness and strategic collaboration (Romero *et al.*, 2016). Increasingly construed as "partners" (Grudin, 2017), smart computational systems, robots and devices augment the cognitive, sensorial and physical capacities of humans (Romero *et al.*, 2016) and create joint-cognitive systems (Jones *et al.*, 2018) and hybrid teaming arrangements (Richert, 2018). Thus, digitalisation decreases the physical and cognitive distance between humans and machines *requiring workers to possess a positive and trusting disposition towards technological entities*.

The second characteristic of digitalised work relates to technological change, increasing role flexibility, the prevalence of emergent problems and highly configurable systems (Fischer and Pöhler, 2018; Hecklau *et al.*, 2016). To function successfully, *humans must develop a high tolerance for environmental and technological dynamism,* with increasing demands for "run-time" decision-making, managing complex tasks and functioning across boundaries. Moreover, workers at all levels will be required to *pursue constant technology-related learning and training* (Freddi, 2018; Hämäläinen *et al.*, 2015).

A final characteristic relates to the breakdown of hierarchical structures within digitalised systems and the broad distribution of decision-making power. This facet of digitalised work is addressed, for example, by holonic system theory, which defines "holons" as biological or non-biological entities capable of autonomous activity, information processing and purposeful interaction with other holons (Pacaux-Lemoine *et al.*, 2017; Wang and Haghighi, 2016). Consistent with this perspective, human workers should possess *high levels of decision-making empowerment and low psychocultural dependence on hierarchical control systems*.

Figure 1 summarises these theorised characteristics of digitalised work. Together they constitute a simplified target-activity model to which the readiness profiles generated in this study will be related.

Instrument translation, recruitment and data collection

Associated members of the sponsoring research and development projects in Ukraine and Latvia collected data in the first quarter of 2019 following ethics reviews by scientific councils at the host universities. The PCO and A-IT scales were translated and deployed in secure online

	Factors	Description
1	Positive effects of IT (PE)	Sense of optimism regarding the effects of IT at work
2	Negative impact of IT (NI)	Sense of anxiety towards potential threats of IT to human wellness and the world
3	Interest in learning about IT (LN)	Interest and motivation to engage with IT-related science, news, films and books
4	Practical value of IT (PV)	Belief in the general value of IT for making people's lives better in multiple contexts
5	Equality of opportunity in IT workplaces (GE)	Belief that IT workplaces provide equal opportunities to both males and females

Table 2. Overview of measured attitudes towards information technology

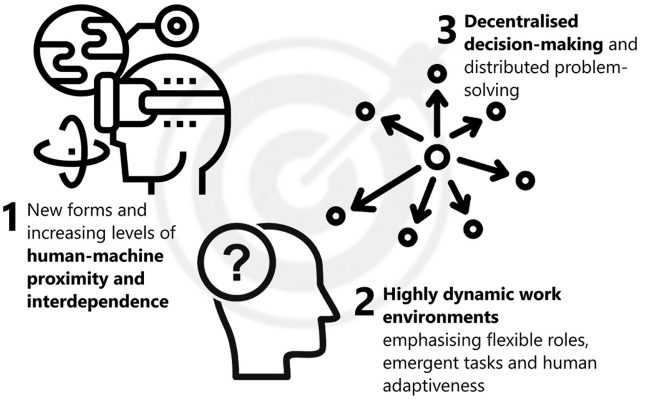

Figure 1.
Three critical facets of digitalised work environments – the target activity

environments after receiving written permission from their original authors. The translation of both instruments from English to Ukrainian and Latvian was coordinated by two multi-lingual scholars and then reviewed by two other multi-lingual scholars. In Ukraine, respondents were recruited from Ternopil National Economic University (TNEU), a large university hosting about 24,000 students and 700 instructors in economics, business and IT. In total, 730 students completed the PCO and 753 the A-IT survey. In Latvia, respondents were recruited from Rēzekne Academy of Technologies, a regional university focused on education, IT and economics. In total, 290 students completed the PCO and 260 the A-IT survey. Although students were drawn from a slightly different mix of university departments in each nation, these samples were considered comparable for this study. The sociodemographic characteristics of respondents, organised by nation and instrument, are shown in Table 3.

Factor selection

Two of the authors reviewed the 15 constructs measured by the two survey instruments against the target activity model. Through iterative rounds of concept mapping and deliberation, they selected five dispositional constructs as the most relevant readiness factors for digitalised work (addressing RQ2). These included three attitudes from the A-IT and two

Variables	Values	Ukraine (PCO[a]: $N = 730$; A-IT[b]: $N = 753$) PCO	PCO %	A-IT[c]	A-IT%	Latvia (PCO: $N = 290$; A-IT: $N = 260$) PCO	PCO %	A-IT	A-IT %
Gender	Male	271	37	282	37	47	16	44	17
	Female	455	62	467	62	241	83	213	82
	No response	4	<1	4	<1	2	<1	3	<1
Age group	<20	199	27	–	–	28	10	23	9
	20–29	464	64	–	–	100	34	94	36
	30–39	21	3	–	–	54	19	51	17
	40–49	33	5	–	–	30	10	26	10
	50+	13	2	–	–	29	10	16	6
	No response	0	0	–	–	49	17	50	19

Note(s): [a]PCO© = personal cultural orientations instrument
[b]A-IT = Attitudes towards Information Technology survey
[c]Age data were not collected with this instrument in Ukraine

Table 3.
Sociodemographic characteristics of respondents by country and survey instrument

personal–cultural orientations from the PCO scale, as shown in Table 4. The conceptual mapping for each factor was defined as follows. A positive attitude towards IT in work environments and low technology anxiety (measured by the A-IT PE and NI subscales) were related to human–machine interdependence. Intolerance to ambiguity and an interest in learning about technology (measured by PCO AMB and AI-T LN subscales) were related to environmental (e.g. technological, role and task) dynamism. Finally, a strong sense of decision-making empowerment (measured by the PCO POW subscale) was related to emergent problem-solving and decentralised decision-making.

The 20 total indicators from these subscales are presented in the Appendix. Two minor modifications were made to the subscales as developed initially. One item from the original A-IT NI subscale was excluded owing to a translation error. Also, one item from the A-IT's PE subscale was excluded for semantic inconsistency. Unlike all other items in the subscale, this item was not situated conceptually *in the workplace*, and when measuring attitudes, maintaining a consistent target context is essential (Hitlin and Pinkston, 2013) [3].

Subscale testing

The subscales used to measure the selected factors were tested for reliability and validity. Importantly, the A-IT and PCO instruments were initially developed and tested with data drawn from Western and East Asian samples (Gokhale *et al.*, 2013; Sharma, 2009). For this study, the validity and reliability of the selected subscales were tested via a two-step procedure, adapting the guidelines of Crutzen and Peters (2017). A confirmatory factor analysis was conducted to test the construct validity of the five inherited subscales (minus the two dropped items) selected as relevant to the characteristics of digitalised work. As shown in Table 5, the measures suggested a good fit for all subscales based on the Ukrainian and Latvian data sets.

The internal reliability of the scales was tested using McDonald's omega (Dunn *et al.*, 2014). As shown in Table 6, the LN subscale produced high omega values (greater than 0.8), which is consistent with its conceptual tightness. The three-item PE and NI subscales produced omega values ranging from 0.6 to 0.72, suggesting a lower level of internal consistency. On the one hand, these values indicate that further instrument development might be beneficial. On the other hand, given the conceptual breadth of the optimism- and

	Construct	Subscale	Target alignment	Readiness directionality
1	Optimism towards IT at work	A-IT PE	Characteristic 1: Human–machine proximity and interdependence	Higher levels preferred
2	Anxiety about IT in general	A-IT NI	Characteristic 1: Human–machine proximity and interdependence	Lower levels preferred
3	Intolerance towards ambiguous/unstructured situations	PCO AMB[a]	Characteristic 2: Highly dynamic and technologically complex work environments	Lower levels preferred
4	Interest in learning about IT	AI-T LN	Characteristic 2: Highly dynamic and technologically complex work environments	Higher levels preferred
5	Tolerance for hierarchical decision making	PCO POW[b]	Characteristic 3: Decentralised decision-making and front-line problem-solving	Lower levels preferred

Note(s): [a]AMB addresses ambiguity *intolerance* and therefore lower measurements represent higher levels of tolerance

[b]POW measures tolerance of top-down control and therefore lower levels indicate higher levels of decision-making empowerment

Table 4. Constructs positioned as readiness factors for digitalised work

anxiety-related attitudes measured by the three-item PE and NI subscales, these results were considered adequate for this study (Crutzen and Peters, 2017). The two subscales drawn from the PCO instrument produced omega values from 0.72 to 0.79, suggesting good levels of internal consistency.

Quantitative data analysis

The data were analysed as follows. First, addressing RQ3, factor level profiles were produced using averaged subscale score for each respondent (Willits *et al.*, 2016). Rounded scores were used to position percentages of Ukrainians and Latvians in response segments for each of the factors. More specifically, participants with rounded response scores above and below neutral (defined as three on the five-point A-IT scale and four on the seven-point PCO scale) were placed in "high" and "low" respondent segments for each subscale [4]. This segmentation procedure produced accessible comparative profiles for the Ukrainian and Latvian student cohorts that have proved useful in other readiness research contexts (Blayone *et al.*, 2018a, b). To investigate significant differences between national groups (as a whole) on each subscale, Independent Samples *T*-Tests were conducted for each factor. This parametric test is robust even when analysing Likert-scale data with unequal variances and non-normal distributions (Norman, 2010).

Finally, addressing RQ4, an aggregate readiness profile was generated to interpret and compare the overall dispositional readiness of the Ukrainian and Latvia respondent groups for digitalised work.

Results

Factor 1: optimism towards IT at work

Optimism towards IT at work was measured with the three-item PE subscale. As shown in Figure 2, large segments of respondents reported beliefs that IT contributes positively to work environments (43.4% measuring high in Ukraine and 33.5 % in Latvia). However, most respondents in both countries were neutral (44% Ukraine; 52.3% Latvia), and small segments were pessimistic (12.6% Ukraine and 14.2% Latvia). The difference in attitudes between Ukrainians ($M = 3.34$, SD = 0.73) and Latvians ($M = 3.23$, SD = 0.68) on this subscale *was significant*: $t\ (1011) = -2.22$, $p = 0.027$.

Table 5. Results of confirmatory factor analysis for the selected subscales

Subscales	χ^2	df	χ^2/df	CFI	RMSEA	Ci. (90%)	SRMR	PNFI
PE, NI, LN UA A-IT ($N = 753$)	201.21	51	3.95	0.937	0.063	0.054–0.072	0.048	0.709
PE, NI, LN LAT A-IT ($N = 260$)	91.04	51	1.8	0.966	0.055	0.036–0.073	0.051	0.716
AMB, POW UA PCO ($N = 730$)	457.53	98	4.67	0.900	0.072	0.065–0.078	0.06	0.707
AMB, POW LAT PCO ($N = 290$)	262.32	98	2.76	0.900	0.076	0.065–0.087	0.063	0.693

Note(s): For χ^2/df, good-fit ratios range from 5.0 to 2.0 with lower being better; for CFI, a good-fit value is greater or equal to 0.90, with some preferring 0.95; RMSEA values below 0.08 suggest a marginal fit and below 0.07, a good fit; SRMR values below 0.08 suggest a marginal fit and below 0.05, an excellent fit; PNFI good-fit values range from 0.5 to 0.9 (Hooper *et al.*, 2008)

Table 6. Results of reliability testing via McDonald's omega

	Ukrainian subscales					Latvian subscales				
	PE	NI	LN	AMB	POW	PE	NI	LN	AMB	POW
ω	0.6	0.66	0.84	0.72	0.75	0.62	0.72	0.89	0.74	0.79

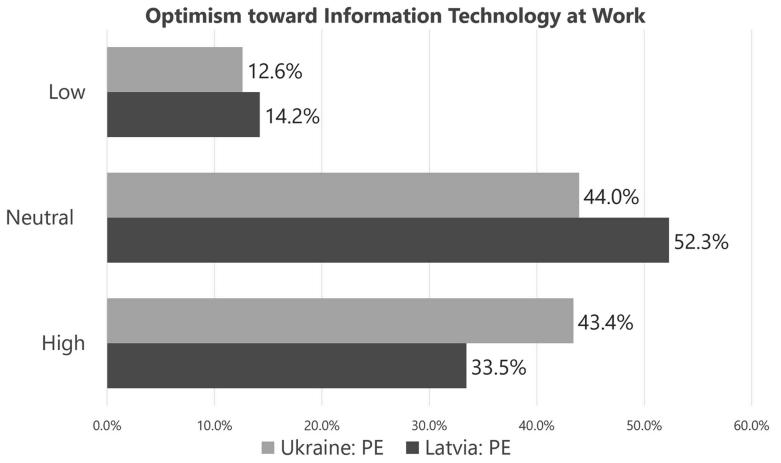

Figure 2.
Response segments for optimism towards IT at work (Latvia $N = 260$; Ukraine $N = 753$)

Factor 2: anxiety towards negative IT impacts

Anxiety about potential negative impacts of IT was measured with the three-item NI subscale. As shown in Figure 3, most Ukrainians (43.2%) reported low concern with negative impacts, with another sizable segment reporting a neutral disposition (41.2%). Only 15.7% reported high levels of concern. In Latvia, 31.2% of respondents reported low concern with larger neutral (46.5%) and high-anxiety segments (22.3%). The difference in attitudes between Ukrainians ($M = 2.7$; SD = 0.82) and Latvians ($M = 2.93$, SD = 0.82) on this subscale *was significant*: t (1011) = 3.98, p = <0.001.

Factor 3: intolerance for ambiguous work environments

Intolerance of ambiguous or unstructured work environments was measured using the four-item AMB subscale, in which lower levels of agreement suggest a more positive disposition towards highly dynamic and unstructured environments. As shown in Figure 4, most respondents in both groups reported high levels of intolerance (Ukraine: 52.6%; Latvia:

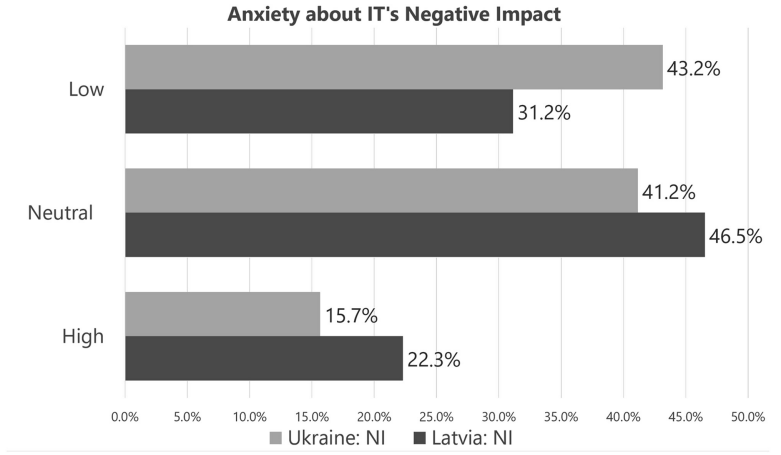

Figure 3.
Response segments for anxiety towards negative IT impacts (Latvia $N = 260$; Ukraine $N = 753$)

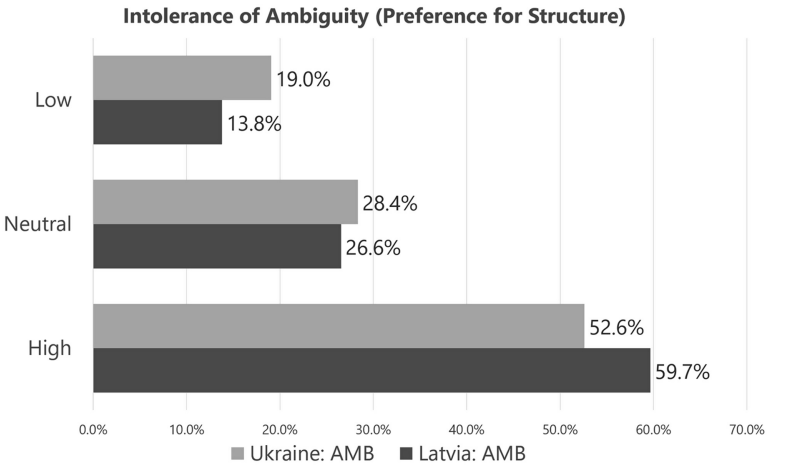

Figure 4.
Response segments for intolerance of ambiguous work environments (Latvia $N = 290$; Ukraine $N = 730$)

59.7%) with substantial neutral segments. Only small numbers of respondents (Ukraine: 19%; Latvia: 13.8%) reported low intolerance. The difference in attitudes between Ukrainians ($M = 4.38$; SD = 1.14) and Latvians ($M = 4.51$, SD = 1.09) on this subscale was *not* significant: t (1018) = 1.58, $p = 0.115$.

Factor 4: interest in learning about IT

Interest in learning about IT was measured using the six-item LN subscale. As shown in Figure 5, most Ukrainian respondents (54.4%) reported a strong interest, with only 6% reporting a low interest. Among Latvia respondents, 43.1% reported a high interest, with 13.8% reporting a low interest. In both groups, neutral responses were substantial. The difference in attitudes between Ukrainians ($M = 3.5$; SD = 0.7) and Latvians ($M = 3.2$, SD = 0.77) on this subscale *was significant*: t (1011) = −5.36, $p = <0.001$.

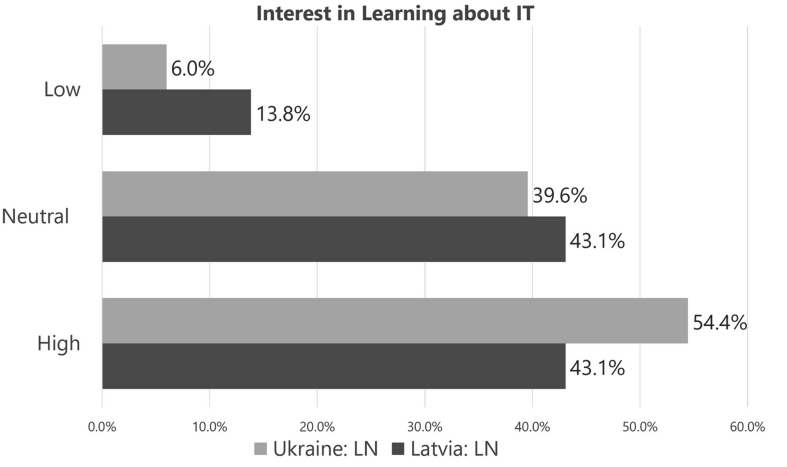

Figure 5.
Response segments for interest in learning about IT (Latvia $N = 260$; Ukraine $N = 753$)

Factor 5: decision-making empowerment

The decision-making empowerment of respondents was investigated using a four-item subscale measuring tolerance to "top-down" control. Less agreement with the items on this subscale suggested a higher sense of empowerment. As shown in Figure 6, 51.8% of Latvians and 42.7% of Ukrainians reported a strong tolerance for top-down decision-making. Only 29.6% of Ukrainians and 18.6% of Latvians reported a low level. In both nations, neutral responses were also substantial. The difference in attitudes between Ukrainians (M = 4.0; SD = 1.2) and Latvians (M = 4.27, SD = 1.1) on this subscale *was significant*: t (1018) = 3.04, p = 0.002.

Composite readiness profile

The composite readiness profile, shown in Figure 7, presents the respondent segments in each national group that reported: (1) high or very high levels of PE, suggesting an optimistic deposition towards IT in work environments aligned with increasing levels of human–machine intimacy; (2) low or very low levels of NI, suggesting minimal anxiety about negative impacts of IT on humans also aligned with human-machine intimacy; (3) low or very low

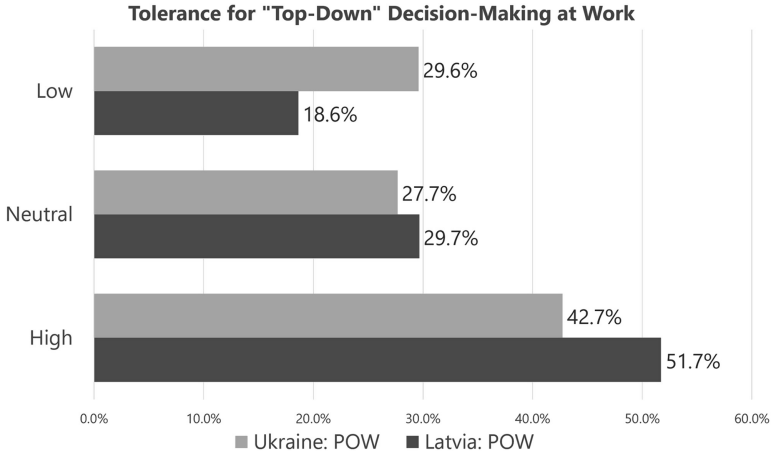

Figure 6.
Response segments for decision-making empowerment (Latvia N = 290; Ukraine N = 730)

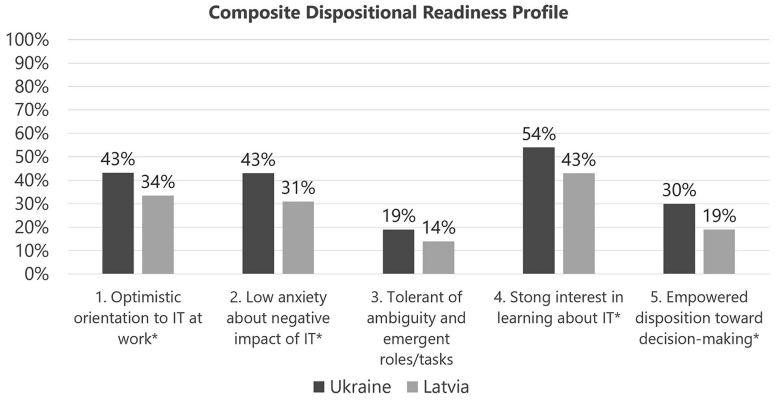

Figure 7.
Composite readiness profile (significant differences marked with an asterisk)

levels of AMB, indicating high tolerance towards unstructured roles and tasks aligned with highly dynamic work environments; (4) high or very high levels of LN, indicating strong interest in learning about information technologies also aligned dynamic environments and (5) low or very low levels of POW, indicating a pre-disposition towards bottom-up decision-making aligned with non-hierarchical work environments.

Summary of findings and discussion

Having received survey data from project teams in Ukraine and Latvia addressing attitudes towards IT and PCO of university students, four logically progressive research questions were defined by the authors. The first two research questions were foundational, producing findings reported above as methodological excurses. RQ1 addressed the defining characteristics of digitalised work (the target activity) and RQ2 the selection and positioning of relevant dispositions (readiness factors) from those measured by the A-IT and PCO scales. Based on a prior literature review, three major characteristics of digitalised work were identified (RQ1). These focused on increasing levels of (1) human–machine interdependence; (2) technological, role and task dynamism and (3) decentralised decision-making protocols. With this three-facet target activity model in place, five of the measured dispositional constructs were conceptually positioned by two of the authors as highly relevant readiness factors (RQ2). Namely, a positive attitude towards IT in work environments and low technology anxiety (measured by the A-IT PE and NI subscales) were related positively to increasing levels of human–machine interdependence. Intolerance to ambiguity (measured by PCO AMB subscale) was related negatively and an interest in learning (measured by the A-IT LN subscale) positively to environmental dynamism. Finally, a low tolerance for hierarchical structures and centralised control (measured by the PCO POW subscale) was related positively to the need for emergent problem solvers and decentralised decision makers.

RQ3 and RQ4 focused on assessing and comparing the dispositional readiness of the Ukrainian and Latvian student groups. Via quantitative analyses, RQ3 was addressed by (1) producing comparative group profiles for each of the selected factors showing the percentage of respondents in each of three readiness segments (high, neutral and low) and (2) testing the group-level data for significant differences via the Independent Samples *T*-Test. The factor-level profiles, displaying common response patterns, nevertheless produced four statistically significant differences (PE, NI, LN and POW) between the two groups. These statistical findings were brought together to produce a composite profile, addressing the overall comparative dispositional readiness of the groups (RQ4). This composite profile highlighted percentages of respondents from each nation reporting dispositions well aligned with digitalised work (as modelled). In each case, the percentage of Ukrainian respondents reporting well-aligned attitudes and personal–cultural orientations were higher than the Latvian groups. However, in our view, the value of the findings rest both in these differences and the overall patterns of similarity.

Overall, the combined strength of both groups relates to their interest in learning about IT, a vital disposition for ongoing professional development. That both countries are increasingly adopting English as a language for business and academic research will ensure access to vast online educational resources for developing technical knowledge and skills. Sizable portions of both groups also recognise the positive effects of IT and report low anxiety about potential negative impacts. These positive dispositions are consistent with broad access to mobile devices and the Internet (International Telecommunication Union, 2019) and bode well for a productive transition to digitalised work environments.

The two measured PCO, however, suggest potential challenges for both nations. A majority of Ukrainian and Latvia respondents reported high levels of ambiguity intolerance,

suggesting a misalignment with contextual dynamism, unstructured activities and emergent problem-solving characteristic of digitalised work. These levels of ambiguity intolerance are consistent with nation-level profiles for both Ukraine and Latvia (Hofstede Insights, 2019a, b). Most Latvians and a large segment of Ukrainians also reported high acceptance of top-down control, an orientation that is misaligned with holonic systems and non-hierarchical decision-making protocols. Here, the Ukrainian response is most consistent with the nation-level profile (Hofstede Insights, 2019b). Somewhat surprisingly, the Latvian response is less consistent with a mid-range nation-level score (Hofstede Insights, 2019a). Given that many Latvian respondents are pedagogical students, this attitude may reflect enculturation into a traditional educational subculture.

As noted, the measures did suggest some stronger dispositional alignments with digitalised work among the Ukrainian sample, with larger percentages reporting an enthusiasm for learning about IT, positive attitudes towards IT and a preference for non-hierarchical decision-making. In Ukraine, these attitudes are consistent with shifting values towards openness and personal empowerment reported, for example, by Euromaidan student activists (Sviatnenko and Vinogradov, 2014). An important and unknown measure in the data, however, relates to pronounced neutral segments from both nations, which are similar in size across subscales. Responses from these neutral segments are challenging to interpret because both national cultures strongly favour restrained expression (Hofstede Insights, 2019a, b). Thus, to what degree neutral respondents possess genuinely neutral attitudes is a question for future research.

Importantly, both countries are pursuing educational reform programs that could facilitate higher levels of dispositional readiness. In our view, forms of digital learning that pursue technological experimentation, democratised decision-making and problem-based activities, appear strongly aligned with the dynamics of digitalised work (Anderson, 2016; Blayone *et al.*, 2017; Garrison, 2017; VanOostveen *et al.*, 2016; Veletsianos, 2016). Addressing pedagogical reforms along these lines remains a priority for this study's sponsoring projects.

Conclusion

This cross-cultural study pursued a shift in workforce readiness research from traditional uses of digital technologies to the emerging dynamics of digitalised work. In our view, the Industry 4.0 literature offers an increasingly detailed and credible vision for establishing the general dynamics of cross-sectoral digitalised work, requiring academics, human resource managers and policy makers to rethink workforce readiness (Kamble *et al.*, 2018; Karacay, 2018; Kergroach, 2017; Liao *et al.*, 2017). As a global techno-social process, digitalisation is redefining relationships between humans, intelligent systems and complex data streams, thus transforming professional roles, tasks and decision-making protocols across market sectors. Some even suggest the COVID-19 pandemic may be accelerating processes of digitalisation in the health sector (Javaid *et al.*, 2020). Certainly, social distancing policies have required students and professionals to become increasingly reliant on digital-mediated communication. Fundamental technology-related attitudes and personal–cultural dispositions of those entering the workforce will have a profound influence on their adaptation to the "new normal." Before addressing the practical implications of this study further, we must acknowledge the research limitations of our efforts.

First, owing to the international scope of the project and independence of the participating research teams, there were limitations in data collection. For example, sociodemographic data were not gathered consistently across all surveys in both contexts. Second, validity and reliability testing suggested that some of the subscales deployed in this study exhibited marginal levels of internal consistency. Third, the target activity (digitalised work) represents a generalised and still underdetermined construct. As an example, it is unclear to what degree

a new technological system triggers changes to practices of hierarchical control that are otherwise culturally dominant. A study of Brazilian manufacturers reported that even the most advanced Industry 4.0 implementations tended to reproduce centralised decision-making protocols (Frank *et al.*, 2019). Fourth, in executing this study, readiness data were obtained via existing self-report instruments initially designed for other purposes. Future projects should develop original models and instruments, theorised and operationalised in direct relation to digitalised work. Finally, the sampled university students were drawn from different mixes of social science, business and technology faculties in each nation as determined by data-collection coordinators. Under more ideal conditions, to strengthen cross-cultural comparisons, researchers might achieve samples from the same domains in each country.

Practical implications for consideration

At least three practical insights can be gleaned from this study for human resource managers, educators, corporate trainers and educational policy makers around the world. First, we would do well to adapt existing worker competency requirements to account for new human–machine interaction scenarios that extend beyond mainstream uses of office computers, mobile devices and the Internet. These include the use of collaborative robots, advanced human–machine interfaces, a variety of wearable devices (e.g. health sensors), big data analysis applications and both augmented and virtual reality systems. In the short term, this may require some initiative and self-study as even leading digital-competency models, such as the EU's digital competence framework (European Commission, 2020), have yet to consider the full force of these emergent technologies. Second, although a variety of basic and advanced technical skills remain vital to worker readiness, technology enthusiasm and learning interest should be recognised as key attitudes supporting the ongoing professional-development requirements of dynamic, digitalised work. Finally, given today's globalised economies and patterns of worker migration, cultural orientations emerge as increasingly relevant sociopsychological forces (alongside personality traits) shaping professional life and organisational dynamics (Thomas and Peterson, 2017). The digitalisation of work is both a technological and *social* process (World Economic Forum, 2016), which is expected to interact with cultural dispositions in predictable ways (Ang *et al.*, 2015; Hofstede *et al.*, 2010). Of course, gaining familiarity with the application and interpretation of well-validated survey instruments is vital. In this regard, two noteworthy research-based initiatives offering practice-focused resources and training opportunities are the Hofstede Insights network (Hofstede Insights, 2020) and the Cultural Intelligence Center (Cultural Intelligence Center, 2020). In our view, students, educators and human resource professionals must approach cross-cultural intelligence as an essential facet of readiness for digitalised work.

Suggested next steps for practice-oriented researchers include improving available factor and target models, extending the scope of data collection to other national contexts and pursuing mixed-methods analyses (e.g. combing survey data with interviews and case studies). Techno-social developments in education, business marketing, urban development, manufacturing, health and other domains, featuring an increasing dependence on "smart" technologies and ubiquitous computational systems is a pervasive phenomenon requiring a collective focus on rethinking worker readiness.

Notes

1. The full questionnaire (PCO scale) is published in this cited article. As detailed below, this study analysed data generated via two of the ten constituent subscales only.
2. The full questionnaire (A-IT scale) is published in this cited article. As detailed below, this study analysed data generated via three of the five constituent subscales only.

3. An exploratory factor analysis, suggesting this item was poorly correlated with other items in the subscale (particularly in Ukraine) drew our attention to this semantic issue. However, it was excluded by the authors on *semantic* grounds.
4. "High" and "low" must be interpreted contextually depending on the directionality of the measures. For example, those reporting high intolerance of ambiguous situations (measured by the PCO AMB subscale) would be considered dispositionally misaligned with the target activity.

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Appendix

Selected subscales

As reported in the text, the five subscales deployed in this study for measuring discrete attitudes and personal–cultural orientations were drawn from (1) the Attitudes Toward Information Technology (A-IT) scale (Gokhale *et al.*, 2013), a 30-item questionnaire measuring five attitudes on a five-point Likert scale of agreement and (2) the personal–cultural orientations (PCO) scale (Sharma, 2009), a 40-item questionnaire measuring ten personal-cultural orientations on a seven-point Likert scale of agreement. The full instruments are available via the works cited above and were deployed for data collection in Latvia and Ukraine with the expressed permission of the instruments' authors. Based on the data sets generated for this study, one item from the A-IT PE subscale (PE4, in italics) was dropped from our analysis based on a semantic review by the authors (cf. p. 11). One item from A-IT NI subscale (NI1, in italics) was dropped owing to a translation error (cf. p. 10). The remaining subscales were used as originally developed.

A-IT PE subscale: Positive effect of IT on work life

PE1: In general, information technology (IT) will create more jobs than it eliminates

PE2: Because of Information Technology, work will become more appealing
PE3: Family-friendly environments are more available in Information Technology occupations than others
PE4: Because of Information Technology, there will be more opportunities for the next generation

A-IT NI Subscale: Negative impact of IT
NI1: Information Technology makes our way of life change too fast
NI2: Advancements in Information Technology will eventually destroy the Earth
NI3: People would do better by living a simpler life without so much Information Technology
NI4: Information Technology applications create an artificial and inhuman way of living
AI-T LN Subscale: Interest in learning about IT
LN1: I enjoy learning about new Information Technology discoveries
LN2: I am well informed about new developments in Information Technology
LN3: I am interested in new applications of Information Technology for improving our lives
LN4: I like to read about Information Technology-related topics
LN5: I like to watch films and videos that have Information Technology-related themes
LN6: I have looked for information about Information Technology advances on the internet

PCO POW subscale: Orientation towards top-down decision-making
POW1: I easily conform to the wishes of someone in a higher position than mine
POW2: It is difficult for me to refuse a request if someone senior asks me
POW3: I tend to follow orders without asking any questions
POW4: I find it hard to disagree with authority figures

PCO AMB subscale: Intolerance towards unstructured work environments
AMB1: I find it difficult to function without clear directions and instructions
AMB2: I prefer specific instructions to broad guidelines
AMB3: I tend to get anxious easily when I do not know an outcome
AMB4: I feel stressful when I cannot predict consequences

Corresponding author
Todd J.B. Blayone can be contacted at: todd.blayone@ontariotechu.net