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The general technological competency model for vocational teachers in Kazakhstan

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Abstract

Like in many Global South countries, the vocational education and training system in Kazakhstan has some weaknesses, including low-competent educators poorly applying digital technologies in their instructional repertoire, which highlights the need for motivating teachers towards incorporating technologies representing students' everyday life in the educational process. Meanwhile, there are no practically applicable competency frameworks for Kazakhstani vocational teachers to date. This paper aimed to gather students' opinions on which skills are more or less important for vocational educators to outline a technological competency framework for Kazakhstani vocational teachers based on Digital Competency Profiler, with content validity tested by five experts. A set of nineteen items measured on a five-point Likert scale, organized into technical, communicational, informational, and epistemological domains, was uploaded to an online survey platform and distributed among Master degree students enrolled in vocational programs in Kazakhstan. Based on survey data, the construct validity of the model was assessed by confirmatory factor analysis, which yielded high entire reliability and internal consistency. The learners assigned importance to all the four domains. However, they estimated vocational teacher's ability to utilize productivity tracking tools as almost futile,

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which allegedly indicates the surveyees' insufficient awareness about those applications and their purposes. Generally, the participants tend to prioritize vocational educators' capacities to process mathematical computations, visualize numerical data, and operate with electronic text files and projectors, as well as their readiness for effective communication through messengers and electronic mail. The framework that emerged from this research can be used as a blueprint for synchronizing and improving educational programs in Kazakhstan.

Keywords: education; survey; technology; ICT; vocational education and training.

1. Introduction

1.1. Background

The COVID-19 epidemic outbreak has required the immediate implementation of remote learning technologies in a lot of countries around the world. Curiously, even developed countries' education systems have reportedly faced some issues pertaining to teachers' digital technology readiness (Carrillo & Flores, 2020; Chen et al., 2020) and poor Internet connection or limited Internet coverage (Lieberman et al., 2021). In the meantime, Kazakhstan is a highly corrupt country with a plethora of corruption crimes in the field of education (Organisation for Economic Co-operation and Development, 2019) and the corruption perceptions index score of 34 in 2019 (Transparency International, 2019), which aligns Kazakhstan with sub-Saharan Africa countries. It is therefore not surprising that Kazakhstan has proved unable to meet the pandemic challenges, demonstrating the absence of the relevant curated content (Privacy Shield Frameworks, 2020), as well as deficient access of the population to Internet and technological devices (Central Asian Bureau for Analytical Reporting, 2020) despite billion-tenge injections into the "e-learning" system. However, digital transformation was showing itself especially in the field of education before the pandemic process.

At the same time, incorporation of technologies representing students' everyday life in teaching and learning processes might encourage their interest, promote inclusion, increase motivation, enhance feedback practices, accelerate and deepen their comprehension of a subject, and make educational activities learner-centered (Rizov & Rizova, 2015; Stanojević, Cenić, & Cenić, 2018; Fuchsova & Korenova, 2019; Kuzmanović, Andjelković Labrović, & Nikodijević, 2019; Záhorec, Hašková, & Munk, 2019). In a research by Matić (2013) the majority of interviewed vocational students acknowledged technology-based education as more effective rather than the traditional approach. Although there are a number of intrinsic obstacles to teachers' engagement in digital pedagogy, such as anxiety about a workload increase (Sánchez & Alemán, 2011; Lawrence & Tar, 2018; Tran et al., 2020), several studies indicate a positive correlation between appropriate resources accessibility and teacher technology implementation, so educators are likely to be ready to integrate information and communication technologies (ICT) in the teaching process, provided that the necessary infrastructure and equipment were made available (Huber & Helm, 2020; Owais et al., 2020). However, evidence also suggests that the critical factor is not so much the digital environment availability as a teacher's capacity to integrate it into education (Veličković & Stošić, 2016; Blikstad-Balas & Davies, 2017; Aflalo, Zana, & Huri, 2018; Baker et al., 2018). For instance, based on hundreds of video-recorded lessons from 47 lower-secondary schools equipped with high technological facilities across Norway, Blikstad-Balas and Klette (2019) had to note the teachers' immensely poor ICT application in their instructional repertoire (predominantly monological PowerPoint presentations), underscoring the necessity of didactical motivation of educators towards digital technology.

Technological competency is one of the four core competencies constituting a teacher's innovativeness as posited by Zhu et al. (2013). After the long-term research, François Desjardins and others have elaborated the General Technology Competency and Use test assessing technical, social, informational, and epistemological dimensions of one's readiness for using a range of digital technologies (Blayone et al., 2017; DiGiuseppe et al., 2017), which can be regarded as reflecting the approximate meaning of technological competency.

It is worth noting that the present research is focused on educators' general technology competency measured by means of translated and culturally adapted Desjardin's General Technology Competency and Use framework (see details in the Methods section), which deals with one's ability to interact with people and digital knowledge artifacts through technological objects, as well as produce some intellectual outcomes. It approximately corresponds to the technology component of teachers' knowledge in the Technology, Pedagogy, and Content Knowledge (TPACK) framework (a detailed description of the model can be found in Wright & Akgunduz, 2018), while two other integral elements of that model (pedagogy and content) are outside the scope of the study described herein. Anyway, it is our view that technology shifts that have taken place over 15 years since TPACK emergence are likely to exacerbate the lack of the integrative relationship between the three domains within actual education practice, which is highlighted by Falloon (2020).

1.2. Why it is important to do this study

We have failed to find any clear data on how technologically competent vocational teachers in Kazakhstan. Howbeit, according to a report (Álvarez-Galván, 2014), the true professional capacity of Kazakhstani vocational teachers is inadequate to the demands of the labor market. No practically applicable competency frameworks for Kazakhstani vocational teachers could be identified withal. There is a professional standard established in Kazakhstan (The National Chamber of Entrepreneurs of the Republic of Kazakhstan "Atameken", 2017), but it mainly comes to vague generalities, such as "knowledge of traditional technologies and didactic teaching aids, including ICT." Meanwhile, some works addressing vocational education and training (VET) in Kazakhstan point out its shortcomings, including weak logistical and financial resources along with the scarcity of independent competency-based evaluation, inferring the need for modernization and adopting more student-centered approaches (Nabi et al., 2016; Zhanguzhinova, 2018; Zhanguzhinova, Magauova, & Nauryzbaeva, 2016). It is thus safe to state that research on the problem of interest is scarce and empirical evidence is due. This study might contribute to existing literature on the topic, enriching current understanding of which particular skills vocational educators should boost to gain acceptance among students in Kazakhstan.

1.3. The aim of the study

Therefore, it would be useful to provide evidence on perceptions of vocational students regarding the digital-technology abilities of VET teachers they would prioritize to facilitate the awareness and technological competency among Kazakhstani vocational teachers. In this regard, the objective of this study is to outline a technological competency framework for VET teachers matching local-level reality.

2. Methods

A mixed methods research methodology was employed. A survey research was conducted to collect quantitative data providing students' opinions on the subject. Also, an expert method involving content analysis was performed to adapt and validate the questionnaire.

2.1. Instrument development and evaluation

To draft the initial competency framework, a list of questions was derived by the research team from Digital Competency Profiler (DCP) survey instrument (Educational Informatics Laboratory, 2018) measuring one's general technological competency based on Desjardins' framework cited above. The list was iteratively reviewed and adjusted to the local context. To that end, several questions were omitted or reformulated, whilst two were adopted from Jafar et al. (2020) and Tran et al. (2020). This led to a set of 19 general technological competency variables, organized into the four domains of human-computer-human interaction and translated into Russian.

To assess whether questionnaire items really cover the contents, index of item-objective congruence (IOC) values were determined based on scores assigned by five vocational teachers (with no less than ten years of relevant experience) from Abai Kazakh National Pedagogical University (Almaty, Kazakhstan), Saken Seifullin Kazakh Agrotechnical University (Karaganda, Kazakhstan), and the Institute of Postgraduate Education at M. Auezov South Kazakhstan University (Shymkent, Kazakhstan). A simplified equation proposed by Turner and Carlson (2003) was utilized, with a value of 0.75 considered an acceptable lower limit. The data were collected through electronical environments. As a result, the IOC value calculated for each item was 0.8 or more, thus indicating a passable content validity level, so none of the questions were removed. The English-language version of the construct can be seen in Table 1 representing a list of Kazakhstani VET teachers' technological competency domains coded to acronyms (the first word represented by its first letter, plus a variable number) and their variables.

Table 1. Coding acronyms for domains and variables of the technological competency of Kazakhstani vocational education and training teachers

Domains	Variables	Acronyms
Technical dimension	To create/edit electronic documents (word processing, presentations, spreadsheets)	T1
	To create/edit audio recordings (podcasts, voice memos)	T2
	To create/edit multimedia items (photographs, movies, and so forth)	T3
	To use projectors	T4
	To manage accounts (online store, bank, and so forth)	T5
Communicational dimension	To communicate using text/video/audio messaging (WhatsApp, Zoom, Skype, and so forth)	C1
	To communicate using e-mail	C2
	To use social networking systems (Facebook, LinkedIN, and so forth)	C3
	To use collaboration/shared document tools (Microsoft Teams, Dropbox, Google Drive, and so forth)	C4
Informational dimension	To search for journal articles on the Web	I1
	To search for short videos on the Internet (YouTube, Vimeo, and so forth)	I2
	To search for and download digital books (text and audio) from the Internet	I3
Epistemological dimension	To create and use concept maps, flowcharts, and so forth	E1
	To sort large amounts of data	E2
	To produce graphs from numerical data	E3
	To do complex calculations	E4
	To do some form of programming to automate certain processes (macros, scripts, robotics, any programming language, and so forth)	E5
	To use productivity tracking tools (DeskTime, and so forth)	E6
	To troubleshoot basic technology problems (drivers reinstallation, and so forth)	E7

Thus, the four-dimension structure of the original instrument remained unchanged, but the number of items was reduced to nineteen.

2.2. Participants and procedure

The designed questionnaire was uploaded to SurveyPlanet, an online survey platform, and the invitation link requesting voluntary anonymous participation was then distributed among Master's students in VET from the aforementioned institutions by e-mail or social networks. The participants were instructed to indicate their perceived level of importance of each of the 19 skills employing a five-point Likert scale (one being not important, while five being very important). Additionally, socio-demographic variables (age category and sex) were mandatory to specify. The survey was active from September 25, 2020, to December 10, 2020. A total of 158 responses were received. Out of 158 (58.9% females and 41.1% males), 37.5% were under the age of 25, while the age range for the remaining respondents was between 25 and 49 years, distributed in three subgroups. According to the annual report provided by the Bureau of National Statistics of the Republic of Kazakhstan (2020), there were 35,690 Master degree students enrolled in VET programs in Kazakhstan as of 2019. Using an online sample size calculator (National

Business Research Institute, 2020), the conservative 50% response distribution was chosen, with 95% confidence level and 8% margin of error, resulting in a recommended sample size of 150 individuals. Thus, the sample obtained was deemed to be adequately representative of the target population. The study design was approved by the ethics committee of Al Farabi Kazakh National University (approval # IRB00010862).

2.3. Data analysis

2.3.1 Internal consistency and factorial validity analysis

Internal consistency and factorial validity analysis. Based on survey data, the construct validity of the whole four-factor framework was tested through classical confirmatory factor analysis (CFA), yielding Cronbach’s alpha as the lower limit of reliability (Viladrich, Angulo-Brunet, & Doval, 2017), and point estimates of score reliability, as well as the entire model reliability value. In addition, the tool generated such model fit measures as root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). Thereafter, Bayesian CFA/item response theory analysis was performed on each competency domain, outputting estimates for the factor loadings (reflecting item-to-domain correlations) and the entire reliability with their 95% credible intervals, plus Cronbach’s α. An R Shiny-based application created by Byron Gajewski and colleagues (Bott et al., 2018) was utilized.

2.3.2 Descriptive analysis

Correspondence analysis (also referred to as perceptual mapping) was used as a descriptive data reduction technique in NCSS 20.0.3 version (NCSS, LLC. Kaysville, Utah, USA).

3. Results and discussion

Concerning the construct validity analysis, the Bayesian procedure, as can be understood from Figure 1, ended up in Markov chain Monte Carlo rates being within the recommended 20–50% range (Bott et al., 2018). All the loadings were far above the established 0.4 cut-off point (Tadesse, Gillies, & Campbell, 2018). Each of the four factors had entire score reliability values surpassing the corresponding alphas, both being higher than the conventional 0.7 threshold. Although no evidence of any previously conducted factorial analysis of DCP could be retrieved, some data are available for Cronbach’s alphas between 0.76 and 0.94 drawn through the instrument reliability tests (Blayone et al., 2018).

```
Acceptance rates:
   I1   I2   I3
 0.38 0.44 0.45
[[1]]
[[1]][[1]]
   Estimate   Std 2.5% CI 97.5% CI
I1    0.822 0.037   0.742    0.886
I2    0.912 0.025   0.857    0.952
I3    0.889 0.028   0.827    0.934

[[1]][[2]]
     Entire Reliability   Std 2.5% CI 97.5% CI
[1,]              0.918 0.015   0.887    0.945
```

```
Acceptance rates:
   T1   T2   T3   T4   T5
 0.34 0.39 0.37 0.35 0.32
[[1]]
[[1]][[1]]
   Estimate   Std 2.5% CI 97.5% CI
T1    0.725 0.057   0.601    0.822
T2    0.877 0.034   0.804    0.936
T3    0.841 0.046   0.741    0.919
T4    0.801 0.044   0.706    0.878
T5    0.758 0.047   0.654    0.838

[[1]][[2]]
     Entire Reliability   Std 2.5% CI 97.5% CI
[1,]              0.914 0.014   0.883    0.939
```

```
[[2]]
[1] "Cronbach's Alpha: 0.8613"
Acceptance rates:
   E1   E2   E3  E4   E5   E6   E7
 0.35 0.43 0.35 0.4 0.29 0.32 0.33
[[1]]
[[1]][[1]]
   Estimate   Std 2.5% CI 97.5% CI
E1    0.768 0.047   0.663    0.847
E2    0.844 0.038   0.762    0.906
E3    0.839 0.038   0.760    0.907
E4    0.870 0.031   0.802    0.919
E5    0.670 0.057   0.549    0.772
E6    0.743 0.047   0.641    0.825
E7    0.787 0.043   0.693    0.864

[[1]][[2]]
     Entire Reliability   Std 2.5% CI 97.5% CI
[1,]              0.932 0.01     0.91     0.95

[[2]]
[1] "Cronbach's Alpha: 0.8747"
```

```
[[2]]
[1] "Cronbach's Alpha: 0.8502"
Acceptance rates:
   C1   C2   C3   C4
 0.34 0.37 0.36 0.37
[[1]]
[[1]][[1]]
   Estimate   Std 2.5% CI 97.5% CI
C1    0.695 0.061   0.562    0.801
C2    0.732 0.055   0.614    0.828
C3    0.786 0.050   0.679    0.874
C4    0.862 0.040   0.770    0.926

[[1]][[2]]
     Entire Reliability   Std 2.5% CI 97.5% CI
[1,]              0.874 0.022   0.828    0.913

[[2]]
[1] "Cronbach's Alpha: 0.7856"
```

Figure 1. Bayesian confirmatory factor analysis of the views of vocational students on the technological competency framework for vocational educators

The classical-type CFA identified CFI equal to 0.896, thus meeting the required minimum bound set at 0.88 (Subramanian et al., 2016), while TLI of 0.882 was displayed, slightly below the acceptance criteria of 0.9 (Tadesse et al., 2018). There was RMSEA of 0.240, which exceeds the standard 0.10 cut-off point (Kim et al., 2016), but it should be highlighted that RMSEA has been repeatedly found to be upwardly biased by sample size (Chen et al., 2008; Shi, Lee, & Maydeu-Olivares, 2019), and is also dependent on a number of variables included in a model (Kenny and McCoach, 2003), so some scholars suggest against its use for model fit assessment (Kenny, Kaniskan, & McCoach, 2015). However, the obtained CFA estimates (Figure 2) verify the validity of the observed model.

```
Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  F1 =~
    T1                0.556    0.047   11.746    0.000    0.556    0.556
    T2                0.721    0.040   18.033    0.000    0.721    0.721
    T3                0.729    0.035   20.639    0.000    0.729    0.729
    T4                0.696    0.037   18.566    0.000    0.696    0.696
    T5                0.702    0.035   20.157    0.000    0.702    0.702
    C1                0.670    0.038   17.615    0.000    0.670    0.670
    C2                0.686    0.035   19.669    0.000    0.686    0.686
    C3                0.610    0.040   15.193    0.000    0.610    0.610
    C4                0.667    0.040   16.476    0.000    0.667    0.667
    I1                0.640    0.043   14.798    0.000    0.640    0.640
    I2                0.718    0.033   21.495    0.000    0.718    0.718
    I3                0.743    0.034   22.069    0.000    0.743    0.743
    E1                0.738    0.030   24.398    0.000    0.738    0.738
    E2                0.818    0.024   34.060    0.000    0.818    0.818
    E3                0.810    0.027   29.874    0.000    0.810    0.810
    E4                0.686    0.038   17.898    0.000    0.686    0.686
    E5                0.620    0.043   14.553    0.000    0.620    0.620
    E6                0.682    0.036   18.693    0.000    0.682    0.682
    E7                0.737    0.029   25.343    0.000    0.737    0.737

Entire Reliability: 0.9509

Cronbach's Alpha: 0.9034
```

Figure 2. Classical confirmatory factor analysis of the views of vocational students on the technological competency framework for vocational educators

Having executed the relevant background literature revision, we can state that prior researches sought perceptions of VET teachers or students on their preparedness for implementing technologies. Our findings, therefore, could not be discussed in terms of comparisons with past analogous studies.

A technical domain of technological competency framework (T1-T5) presented here comprises five action-device items addressing the basic operational functions possessed by an individual. Kazakhstani vocational students' views on how necessary those skills are for VET educators, depicted in Figure 3. As may be seen, the respondents rated teachers' capability to work with electronic text files and media projector as especially important. In contrast, technical actions associated with various accounts and audio-video content were positioned around the middle point. This highlights the students' adherence to the most accustomed repertoire of instructional tools.

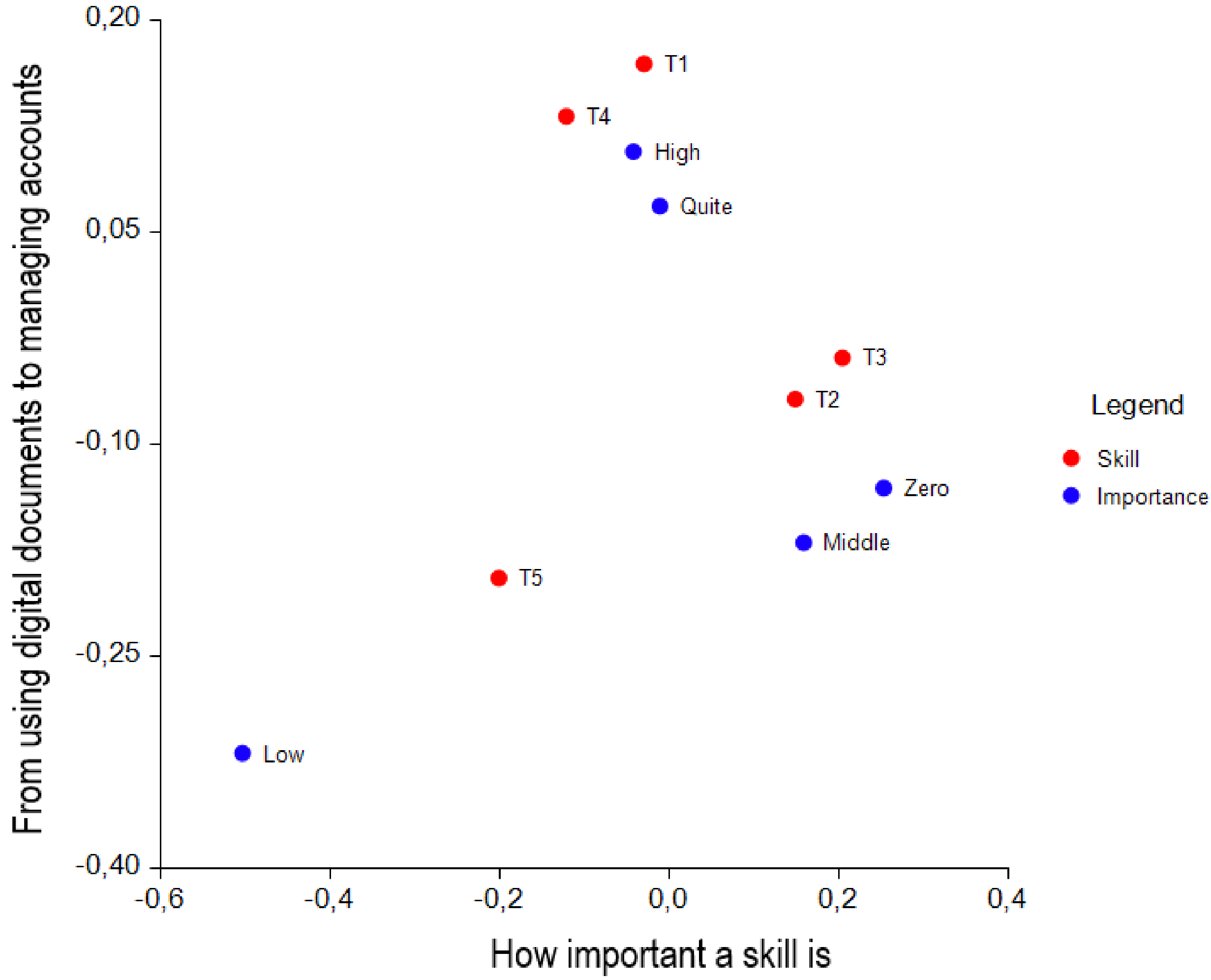

Figure 3. Perceptual map, showing the views of vocational students on a technical domain of the technological competency framework for vocational educators

As for a communicational dimension (C1-C4) covering digitally-mediated social interactions, Figure 4 shows that the survey participants believe the readiness for effective communication through messengers and electronic mail is substantial for a modern VET teacher in Kazakhstan. Simultaneously, the ability to interact through social networking services was estimated as not exactly necessary. Blayone et al. (2018) surmise that social-network usage is not usually attributable to educational context among people, which might be the explanation for this result. Nevertheless, prior evidence suggests that integration of social networks in the educational process could enable students' cooperation and critical thinking (Eger et al., 2020).

Finally, teachers' preparedness for communicating via online collaboration platforms was deemed relatively unimportant. This is hardly surprising since according to a note (Hoftijzer et al., 2020), only the European Union countries started to transfer educational activities to those platforms by virtue of the pandemic.

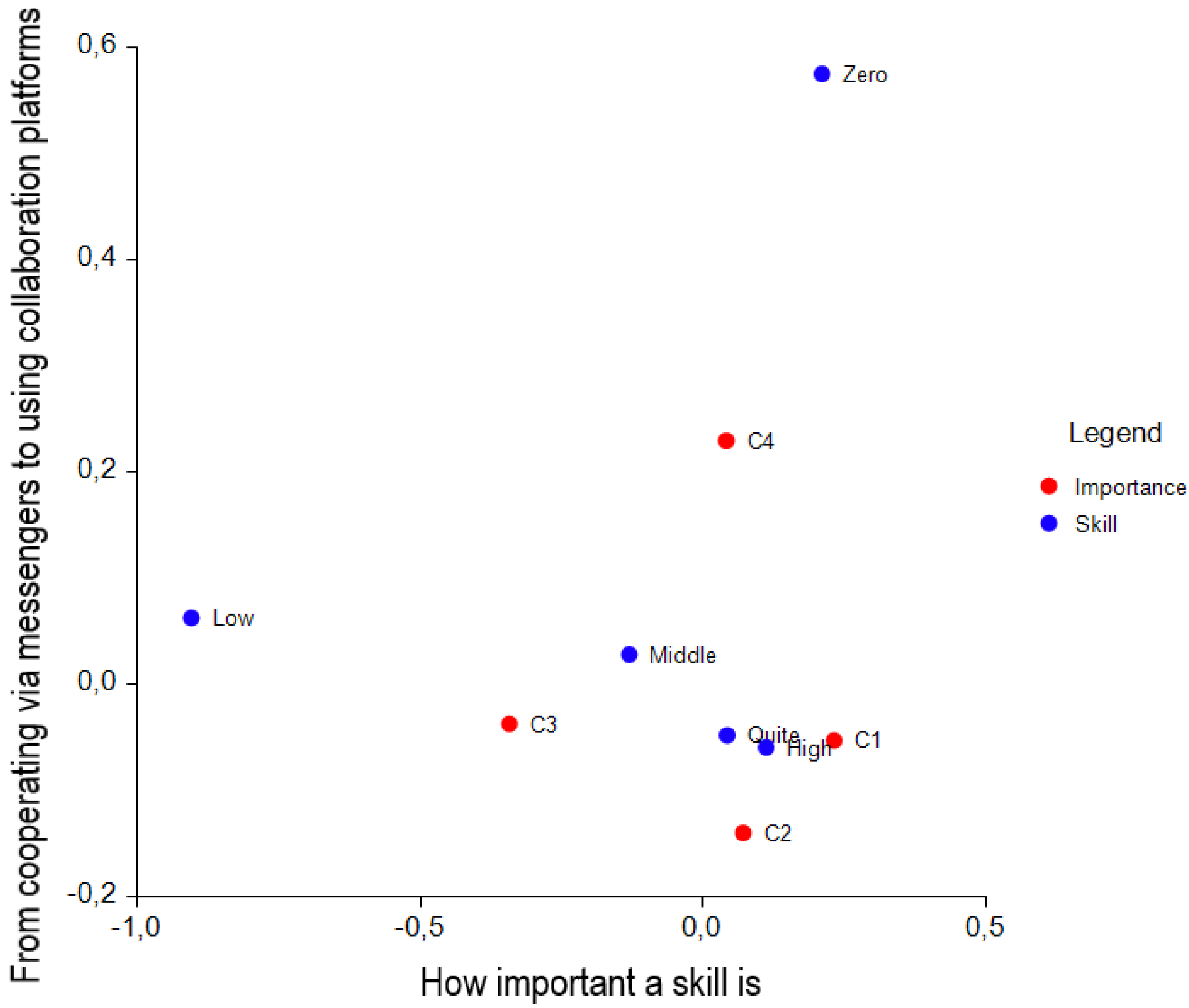

Figure 4. Perceptual map, showing the views of vocational students on a communicational domain of the technological competency framework for vocational educators

An informational order of technological competency (I1-I3) concerns one's capacity to collect and organize information by dint of digital technologies. Judging by Figure 5, there was rather a high level of necessity for VET teacher's abilities to gather online videos and research papers as perceived by the students reported, with moderate importance assigned to the dealing with digital books, which could be construed as the pursuit of a shift away from the routine training methods. A systematic review (Srinivasa, Chen, & Henning, 2020) has summarized the utility of online videos as a medium of instruction supporting the acquisition and retention of procedural skills. Apart from YouTube videos, hyperlinked video is an advanced educational tool, which proved to catalyze augmentation in VET within the Erfahrraum pedagogical model (Schwendimann et al., 2015). Furthermore, with respect to vocational education, even greater augmentation has been demonstrated in car painter apprenticeship in Germany using immersive virtual reality (Mulders, Buchner, & Kerres, 2020).

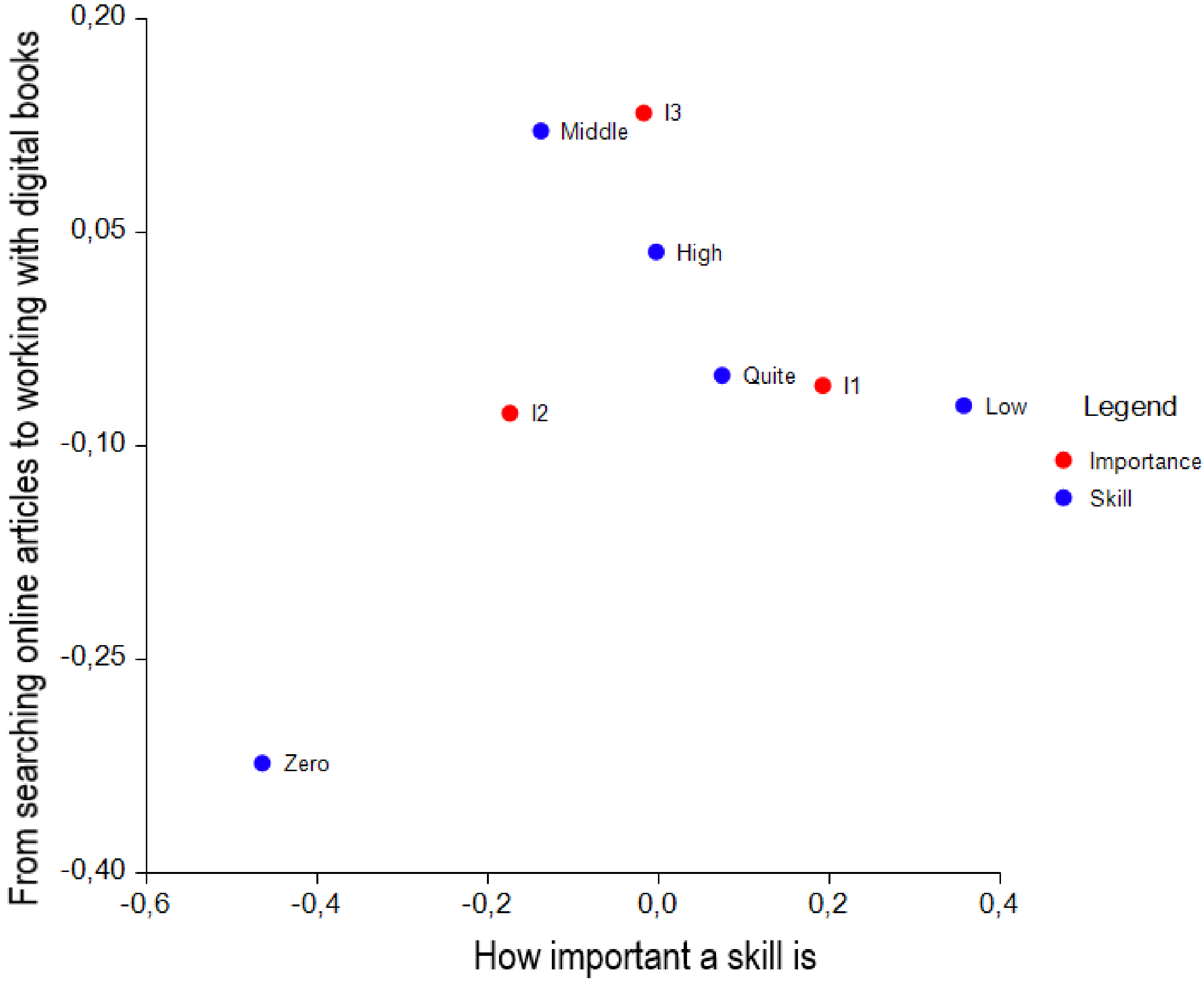

Figure 5. Perceptual map, showing the views of vocational students on an informational domain of the technological competency framework for vocational educators

An epistemological dimension of the framework (E1-E7) implies applying technology-related skills to carry out specific tasks. Figure 6 illustrates the results pertaining to this competency domain. Curiously, the usage of productivity tracking tools was rated by the students as of almost no value. This finding probably points to insufficient awareness of the local population about that type of technology and why it should be applied. Nevertheless, progress tracking is one of the merits of applying up-to-date technology (Stošić, 2015). For example, physical activity monitors have been claimed to contribute to focusing on specific goals (Ráthonyi et al., 2019).

Moreover, there was a mediocre level of importance given to programming skills. The readiness of VET teachers for solving uncomplicated technical failures was found to be considered as sort of requisite but not critical. Perhaps this function is entirely incumbent upon technical personnel in the opinion of the respondents. Meanwhile, the preparedness for operating with voluminous data or concept maps and other such digital objects was estimated by Kazakhstani vocational learners as quite required, whereas capacities to process mathematical computations and visualize numerical data were deemed crucial for VET educators.

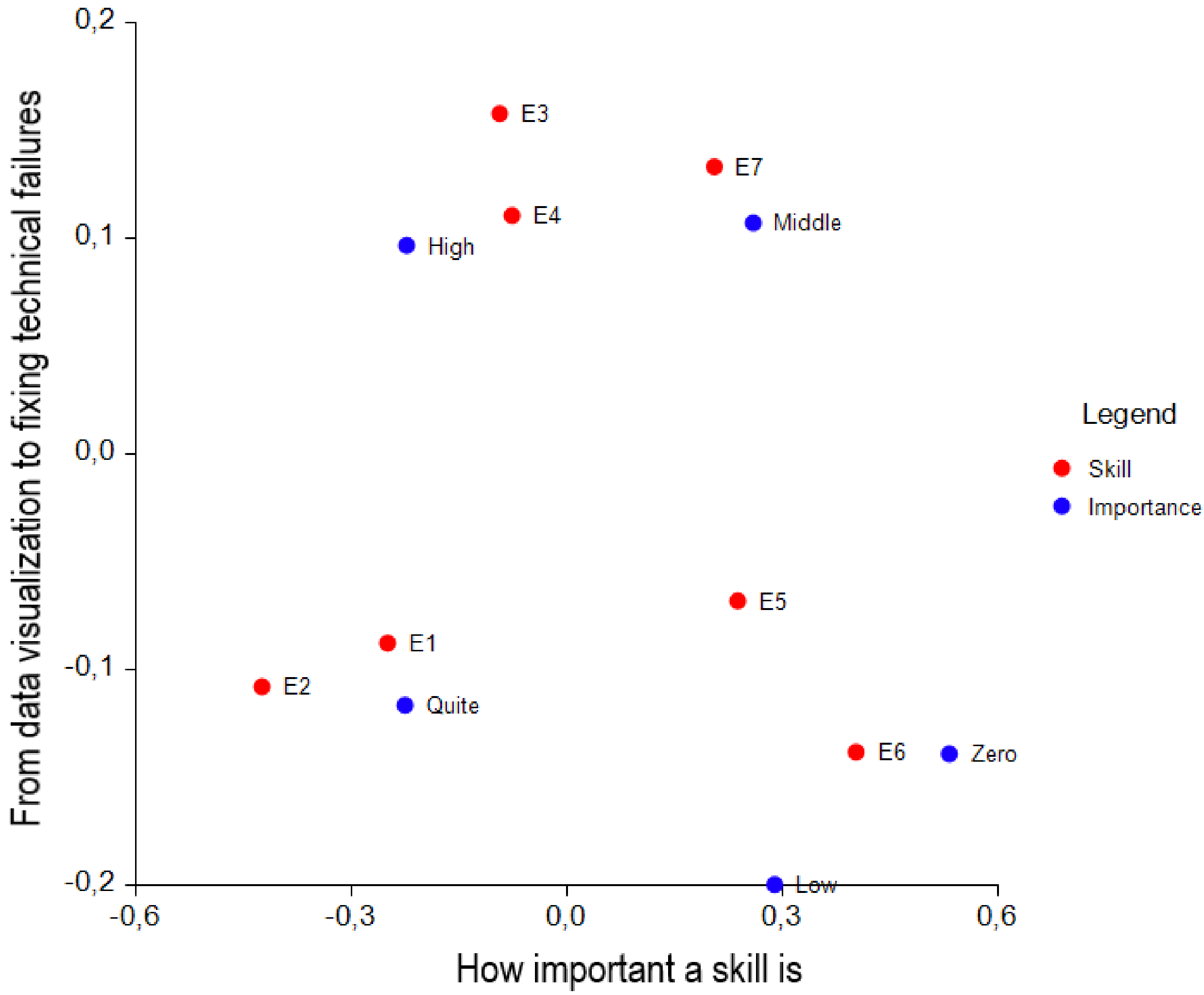

Figure 6. Perceptual map, showing the views of vocational students on an epistemological domain of the technological competency framework for vocational educators

It is noteworthy that the benefits of these skills are not restricted to writing and designing scientific articles or reports. Particularly, a visual analytics technique called “social network analysis” is stated to allow for pedagogues to evaluate interactions between different groups of students with a view to improving group work and learning outcomes (Ndukwe & Daniel, 2020).

4. Conclusions

Thus, Master degree students in Kazakhstan assigned importance to all the four domains of technological competency framework proposed here, namely technical, communicational, informational, and epistemological. Regarding the latter, however, the respondents estimated VET teacher’s ability to apply productivity tracking tools as almost futile, which allegedly indicates that the students are poorly informed about those applications and their purposes. Generally, the vocational learners involved in this survey study tend to prioritize VET educators’ capacities to process mathematical computations, visualize numerical data, and operate with electronic text files and media projectors, as well as their readiness for effective communication through messengers and electronic mail. The technological competency model that emerged from the present investigation suggests the competencies that VET educators should acquire. It could be used as a blueprint for synchronizing and improving VET programs in Kazakhstan, including teacher preparation programs.

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