# School Management Activities in a Digital Age:
# An International Comparison Based on ICILS 2018

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| Abstract | Article Info |
|---|---|
| *Principals have an important role to play in the implementation of digitalization in schools. They can be seen as role models for teachers with regard to information and communication technology (ICT) usage. Furthermore, there is nowadays a solid research linking educational leadership and management indirectly to student* | |

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*achievement. However, there is a lack of studies on the specific ICT usage of principals and the relationship with students' ICT skills. Against this background, our research aimed to find out whether different clusters of principals in Chile, Denmark, Germany, the Republic of Korea, and the United States can be identified on the basis of their leadership and management activities using ICT and whether there are differences in the distribution of the identified clusters across the countries. A latent class analysis was conducted using the International Computer and Information Literacy Study (ICILS) 2018 school questionnaire data. Across the five countries, three different clusters were identified based on principals' activities using ICT. Proportions of principals' distribution across the clusters varied significantly between the countries. In addition, it was investigated whether the clusters are related to students' computer and information literacy (CIL) using the means of student's scores in the computer based CIL test. No significant relation was found either when the five countries were considered together or individually.*

**Cite as:**

## Introduction

Digitalization is permeating the entire world of work and life worldwide (Kupaysinovna & Abduvakhobovich, 2021**;** Rohatgi et al., 2020; Tiede et al., 2015). Digitalization processes are also being driven forward in education systems through educational reforms, the increasing usage of media and technologies in classrooms, and in the routine tasks of teachers and principals around the world (Nadrljanski et al., 2022; Tiede et al., 2015). Principals are often expected to lead the digital transformation in schools to promote students' learning of 21st century skills which will prepare them for life in the digital world (Håkansson Lindqvist & Pettersson, 2019; Rojas Briñez et al., 2023; Tiede et al., 2015). In order to fulfil these tasks, a good understanding of ICT usage in the school context and the corresponding digital skills are required (Dexter, 2018). As leaders, principals are expected to create conditions that promote ICT usage in schools (Dexter, 2018) and act as role models for teachers with regard to ICT usage in the digitalization of the school system (Nababan et al., 2021).

There is strong evidence linking school leadership to the capacity of teachers and (indirectly) to student achievement (Leithwood et al., 2017; Mulford, 2003; Robinson et al., 2008). However, there is a lack of empirical research on the importance of principals for the deployment and (competent) usage of ICT in schools, especially research that uses large international data sets. An international understanding of how principals use ICT and how they might influence ICT integration in schools seems especially important as the pandemic has highlighted the potential of ICT in schooling but also – in many countries – that the current state of integration leaves room for improvement (Karakose et al., 2021; Pietsch et al., 2022; Ramos-Pla et al., 2021).

In this article, we describe the relevance of school leadership in the context of ICT (integration) in schools and introduce the framework of our study including information on national contexts for ICT-related education and students' performance in our five comparison countries: Chile, Denmark, Germany, the Republic of Korea, and the United States. Then, we will present the sources of data and methods, followed by our findings and a discussion including a reflection on areas of future research.

**The relevance of school leadership in a digitalized world**

*School leadership – an increasingly digital profession under pressure?*

The profession of a school leader is characterized as a position of high responsibility (Tan et al., 2022). School leaders are expected to manage – among other things – "enhanced administrative and managerial tasks, handle financial and human resources, manage public relations and build coalitions, engage in quality management and public reporting processes and provide leadership for learning" (Pont et al., 2008, pp. 28–29). Their position has sometimes been likened to that of a middle manager. They are expected to not only be administrators but also drivers of change. They act as points of contact for a variety of stakeholders, among them teachers, students, parents, and local authorities/school boards. As such, acts of communication and information management can be considered two key areas of their job. These domains have been heavily influenced by technological advances over the past two decades and have consequently also changed the day-to-day work of principals (see, e.g., Akhtar, 2022). Nevertheless, there are currently only a few studies on the use of ICT by principals (see, e.g., Tulowitzki et al., 2022). Moreover, existing research is not internationally comparative. An earlier study by Stuart et al. (2009) showed that 64 principals surveyed in New Zealand

frequently use ICT in their work. A study in Canada (Pollock & Hauseman, 2018) based on interviews with 70 school principals revealed that the increasing usage of e-mails was seen as a double-edged sword, providing efficiency but also leading to an increased volume of communication and extension of the workday. Similarly, Akhtar (2022) concludes that while the use of ICT infrastructure improves the effectiveness of Pakistani school management and raises school standards, it can also create additional challenges for principals due to technology failures. Other studies have shown that school principals are considered role models for teachers and other stakeholders with regard to ICT usage (Apsorn et al., 2019; Baydar, 2022). Further research into the usage of ICT by principals therefore appears valuable to identify starting points for the further development of digitalization processes in schools.

We argue that better understanding the ICT usage of principals is relevant on two levels: First, because digital tools and technology are nowadays part of many working contexts including the working context of principals. Second, because the actions of principals, including their use of ICT, can influence the overall technology integration in a school.

### The ICT-related influence of principals

Overall, there have been few studies on the leadership role in educational technology reforms, but the school leadership role is seen as a crucial aspect for successful ICT adoption (Arham et al., 2022; Dexter & Richardson, 2020; Rojas Briñez et al., 2023). Principals have long been identified as "change agents" (Fullan, 1993) that can act as gatekeepers or drivers of innovation in schools (Hall & Hord, 2019), depending on their open innovation mindset (Witthöft et al., 2024). These innovations include ICT usage in schools. Here, principals have

been found to influence teachers' knowledge and usage of ICT (Dexter, 2018; Petersen, 2014; Petko & Prasse, 2018). Principals' engagement in ICT has also been shown to influence teachers' self-efficacy (Ismail et al., 2021), beliefs (Schmitz et al., 2023), and attitudes towards ICT (Petko & Prasse, 2018). The different (ICT-related) leadership approaches that principals can choose also have an impact on their staff (Navaridas-Nalda et al., 2020). In particular, there is an indication that a transformational leadership is linked to (comparatively faster) implementation of ICT by teachers (Ruloff & Petko, 2021; Vermeulen et al., 2015). The concept of transformational leadership originated with Burns (1978) and was further developed by Bass (1985). Next to functions in the area of management and administration, transformational principals lay emphasis on inspiring and motivating teachers, being a role model, and developing a meaningful vision for the future of the school (also see, e.g., Daniëls et al., 2019; Leithwood & Sun, 2012). By using transformational leadership practices, such as setting a good example and thus acting as a role model, principals' own usage of ICT can influence how teachers engage with, perceive and use ICT (see, e.g., Schmitz et al., 2023; Tulowitzky et al., 2023). This is also emphasized in Hope and Stakenas (1999) approach about principals' three primary roles for being a technology leader for better integration of ICT in schools (also see, Mwambo, 2019).

Principals need to interact with various stakeholders in their day-to-day work and build strong relationships in order to successfully lead technological innovation and change in schools (Dexter & Richardson, 2020). The choice of communication methods can have an impact on the quality of these interactions. For example, Mazza (2015) highlighted the potential benefits of US American principals utilizing social media to enhance communication and relationships between

schools and parents, complementing traditional forms of two-way/multi-way communication in the modern era.

Furthermore, there is nowadays a wealth of evidence linking educational leadership indirectly to student outcomes (see, for example ten Bruggencate et al., 2012; Grissom et al., 2021). Principals can influence teacher capacity, motivation and working conditions which then in turn affect classroom instruction and student performance (Leithwood & Louis, 2012; Leithwood et al., 2017; Mulford, 2003). For example, a study in Texas with 1779 primary school teachers and data on student grades has shown that school leadership has a positive indirect impact on student performance by creating a rational climate in the school (Leithwood et al., 2020). The study by Tan (2018) also demonstrated an indirect influence of school leadership on the students' mathematic performance in various countries. With regard to a direct influence, however, the results are different: In various studies, there is little to no direct influence of individual practices of transformational leadership on student performance (Allen et al., 2015; Sun & Leithwood, 2012). In addition, there is currently a lack of studies that deal with the influence of school leadership practices in relation to digital media on student ICT skills.

## Theoretical and empirical framework

### Theoretical framework model

Our research uses secondary analyses to examine school leadership in the context of digitalization. To do this, we draw on data from the *International Computer and Information Literacy Study* (IEA-ICILS 2018). ICILS 2018 is the most recent comparative study providing data about ICT in schools with a representative database. For the second time since 2013, the Computer And Information Literacy (CIL) of Grade 8

students was examined in an international comparison using computer-based test environments. In addition, information on school improvement processes as well as teaching and learning with ICT was collected using questionnaires (Mikheeva & Meyer, 2020). ICILS 2018 as an international comparative large-scale study is based on a theoretical framework model (Fraillon et al., 2020). In line with previous models, it takes into account the multilevel structure when it comes to student learning (e.g. Scheerens, 1990; Scheerens & Bosker, 1997). The model differentiates between antecedents and processes, following the assumptions that antecedents influence processes and that processes are closely connected to the outcome, i.e. the level of CIL competence. School leadership is posited as one of the relevant process factors on the level of the school and the classroom (see Figure 1).
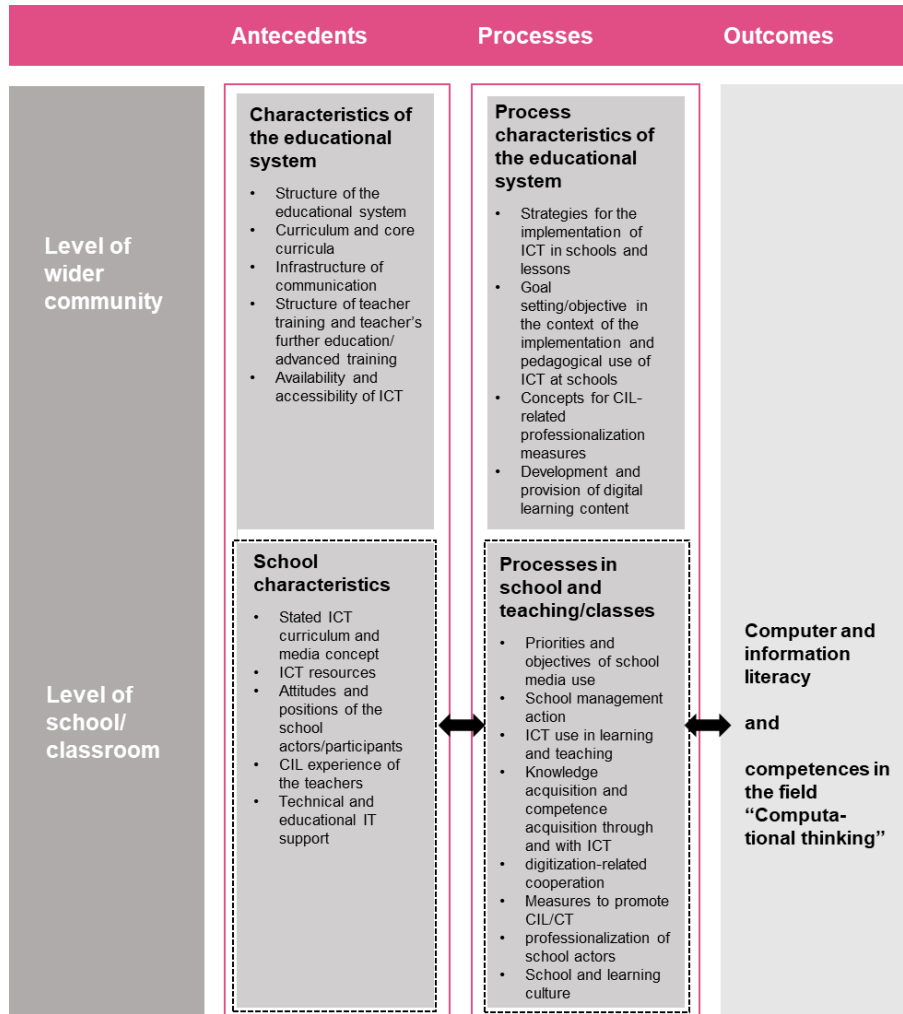
| Antecedents | Processes | Outcomes |
|---|---|---|

**Level of wider community**

**Characteristics of the educational system**
- Structure of the educational system
- Curriculum and core curricula
- Infrastructure of communication
- Structure of teacher training and teacher's further education/advanced training
- Availability and accessibility of ICT

**Process characteristics of the educational system**
- Strategies for the implementation of ICT in schools and lessons
- Goal setting/objective in the context of the implementation and pedagogical use of ICT at schools
- Concepts for CIL-related professionalization measures
- Development and provision of digital learning content

**Level of school/classroom**

**School characteristics**
- Stated ICT curriculum and media concept
- ICT resources
- Attitudes and positions of the school actors/participants
- CIL experience of the teachers
- Technical and educational IT support

**Processes in school and teaching/classes**
- Priorities and objectives of school media use
- School management action
- ICT use in learning and teaching
- Knowledge acquisition and competence acquisition through and with ICT
- digitization-related cooperation
- Measures to promote CIL/CT
- professionalization of school actors
- School and learning culture

**Computer and information literacy**

**and**

**competences in the field "Computational thinking"**

*Figure 1.* Theoretical Framework of the International Computer and Information Literacy Study ( Eickelmann, 2019, shortened and translated by the authors; based on Fraillon et al., 2020)

We therefore take a closer look at this topic in this paper. In order to be able to better interpret the following international comparative

analyses, information on the national context of the countries considered is summarized below.

## National contexts for CIL education

Since, according to the framework, the (process) characteristics of the educational systems have an influence on the school and classroom level, some country-specific background information on the context for CIL education until the ICILS survey in 2018 is provided as follows. The following five countries are considered in this article: Chile, Denmark, Germany, the Republic of Korea, and the United States. These countries were chosen in order to provide a diverse representation of school management activities across four different continents, allowing for a comprehensive global perspective on the issue. In addition, Denmark was used as a comparison country because it is the ICILS winning country where students have the best computer and information skills (Fraillon et al., 2020). Furthermore, the inclusion of both Denmark and Germany allows for an intra-European comparison to further utilize the rich potential of the international data set. As shown in the following, the selected countries cover a wide range of ICT-related educational practices and policies and differ in terms of their level of digitalization and student achievement. This diverse selection of countries enhances the generalizability and applicability of the study findings to a broader context.

First of all, it should be noted that, according to the findings of Fraillon et al. (2020) from the ICILS national contexts survey, the five countries differ in terms of the curricula for ICT usage in the classroom, the timing, and responsibilities for implementing these. While in Chile, Denmark and Korea, guidelines for ICT curricula were defined and implemented at state level, in the USA additional guidelines were

implemented at federal level by 2018, and in Germany only at federal level (Fraillon et al., 2020).

Furthermore, there are differences in the current state of implementation, particularly concerning the availability of technology-related resources for teaching and learning: Results of ICILS 2018 show that while Danish schools are comparatively best equipped, the availability of resources in Chile and Korea varies greatly depending on the resource. In comparison with all ICILS countries, German schools lag behind in terms of technology resources (Fraillon et al., 2020). Denmark also leads in software-related resources, with Korea also performing well in ICILS country comparison. Germany faces shortages in various software resources, while Chile's schools lag overall in software provision. The availability of technology facilities for teaching and student learning is also comparatively good in Denmark, while it varies in Germany depending on the facility and is notably lacking in Chile and Korea in ICILS country comparison. Chile places a higher priority on facilitating ICT usage in education compared to other countries, while Denmark, Germany, and Korea prioritize it less. The United States does not meet the high ICLS sample participation requirements for a comparison across all aspects (Fraillon et al., 2020). It is also difficult to draw general conclusions about the US education system due to its highly decentralized nature, with the national Department of Education playing a minor role compared to the state and local school council level (Vachkova et al., 2021). However, according to ICILS 2018, the United States has a very good availability of technology-related and software-related resources and technology facilities for teaching and student learning. In addition, the United States places a high priority

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on many ways of facilitating ICT use in teaching and learning (Fraillon et al., 2020).

## Students CIL in international comparison

Within the ICILS framework, CIL is defined as the ability "to use computers to investigate, create, and communicate in order to participate effectively" in various areas of life (Fraillon et al., 2020, p. v). Two overarching strands of CIL are distinguished: *Collecting and managing information* which involves "a practical understanding of how to use a computer and the capability to find and critically evaluate online information" and *producing and exchanging information* which includes "communication, safe use of information, secure use of information and transforming and creating digital information" (Rohatgi et al., 2020, p. 145).

Based on the individual test results of the students, five levels of CIL with increasing difficulty are distinguished. With scores between 518 and 553 (see Table 1), students from Denmark, Germany, the Republic of Korea and the United States on average are on Level 2 and thus manage to "use computers, under direct instruction, to complete basic and explicit information gathering and management tasks" (Fraillon et al., 2020, p. 51) while students of Chile are on average in Level 1 and thus "demonstrate a functional working knowledge of computers as tools" (Fraillon et al., 2020, p. 51). The highest average scores can be found in Denmark. In the Republic of Korea, the highest proportion of students (9 %) reached the highest CIL level. These ICILS findings are also reflected in further comparative studies, with Denmark (see, e.g., Rohatgi et al., 2020; Storte et al., 2019) and the Republic of Korea (see, e.g., Fiş Erümit & Keles, 2021) being in particular regarded as global role models in terms of digital integration and student performance.

**Table 1.**

Student performance in CIL in the five countries: results from ICILS 2018

|  | Average CIL scores |
| --- | --- |
| Chile | 476 |
| Denmark | 553 |
| Germany | 518 |
| Republic of Korea | 542 |
| United States[a] | 519 |
| **ICLS Total** | **496** |

[a] does not meet the high IEA sample participation requirements

### Research questions

Due to the lack of international comparative studies on the use of ICT by principals, this topic was examined in more detail in the present study. Therefore, the following three research questions were addressed:

1. Is it possible to empirically identify distinct clusters of principals across Chile, Denmark, Germany, the Republic of Korea, and the United States based on their leadership and management activities using ICT?

2. If so, are there any differences in the distribution of the identified clusters across these five countries?

3. Are the identified clusters related to students' competence in CIL?

The next section explains how such distinct clusters are identified.

### Data sources, methods, statistical techniques

To answer the research questions, data from the second cycle of the *International Computer and Information Literacy Study* (ICILS 2018) was used. The main aim of the study was to investigate to which extent students in grade 8 (or equivalent) have computer and information-related skills. To this purpose, the students completed various computer-based tests. In addition, the framework conditions for skills acquisition were recorded using various additional questionnaires for different stakeholders (Fraillon et al., 2020). This study is based on the information from the school principal questionnaire and the students' test results (see, e.g., Mikheeva & Meyer, 2020). Data from the following countries is taken into account: Chile, Denmark, Germany, the Republic of Korea and the USA. The respondents completed the tests and questionnaires in their respective national languages. Table 2 shows the sample sizes of the principals who took part in the 2018 ICILS survey for the five countries.

**Table 2.**

Sample sizes in the five countries taken into account

|  | Sample size in the analysis sample | Percentage |
|---|---|---|
| Chile | 174 | 19.3 |
| Denmark | 140 | 15.5 |
| Germany | 194 | 21.5 |
| Republic of Korea | 150 | 16.6 |
| United States | 245 | 27.1 |
| **Overall** | **903** | **100.0** |

In order to answer the research question 1, a Latent Class Analysis (LCA) was conducted (Geiser, 2013; Lazarsfeld & Henry, 1968; McCutcheon, 1987) using M*plus* 7.0 (Muthén & Muthén, 2012). Using

methodological approaches to cluster data to identify different classes appears particularly fruitful and has been conducted recently in different contexts using large scale assessment data on the student (e.g. Bundsgaard & Gerick, 2017; Ünlü & Schurig, 2016; Wendt & Kasper, 2016), the teacher (e.g., Eickelmann & Vennemann, 2017), and the school level (Gerick, 2018). In order to identify the statistically optimal amount of clusters, different statistical models are analyzed separately and subsequently compared. To compare the different models, the information criteria *Akaike Information Criterion* (AIC; Akaike, 1974) and the *Bayesian Information Crite*rion (BIC; Schwarz, 1978) were used. Lower AIC and BIC values for a model indicate a better model fit (Rost, 2004). In cases of small differences between models with different amounts of clusters, the selection of the model with fewer clusters is recommended. To assess the reliability of the classification, the average latent class probabilities for most likely latent class membership are considered (Geiser, 2013).

Since the number of schools varies in the five countries, and to make sure that each country contributes the same proportion of data into the LCAs, the school weights in all schools across the five countries were rescaled (Gonzalez, 2012) to a sample size of 150 from each country. This led to an equal weighting of the countries irrespective of the individual sample size within the country. Cases with missing values in any of the relevant variables were omitted from the analyses.

All 14 items of question 3 in the school questionnaire of ICILS 2018 were used in the analyses to answer the research question (Mikheeva & Meyer, 2020), covering facets like using ICT for information search, organization of databases, communication with various stakeholder

and management of various aspects of schools. The following list shows the items used in English:

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**How often do you use ICT for the following activities?**

a) Search for information on the Internet or a network maintained by education authorities for its schools

b) Provide information about an educational issue through a website

c) Look up records in a database (e.g. in a student information system)

d) Maintain, organize and analyze data (e.g. with a spreadsheet or database)

e) Prepare presentations

f) Communicate with teachers in your school

g) Communicate with education authorities

h) Communicate with principals and senior staff in other schools

i) Communicate with parents

j) Work with a learning management system (e.g. [Moodle])

k) Use social media to communicate with the wider community about school-related activities

l) Management of staff (e.g. scheduling, professional development)

m) Preparing the curriculum

n) School financial management

*Response categories: Every day, At least once a week but not every day, At least once a month but not every week, Less than once a month, Never*

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For the second research question, descriptive statistics were calculated in order to illustrate the proportions of principals who can be categorized into the identified clusters for each country. For the third research question, the student achievement in the computer based CIL test were taken into account. For the analyses, mean difference analyses (*t*-Tests) were conducted for all countries together and for each country separately using the means of students score in the five tasks of the test module (plausible values) and the respective

weighting variables. The analyses for research questions 2 and 3 were conducted with the IEA IDB Analyzer 4.0.39 (Mirazchiyski, 2015).

## Results

To answer the *first research question*, we analyzed whether it is possible to identify different clusters across the five countries based on the leadership and management activities using ICT. As table 3 shows, the three-cluster model describes the data particularly well, because the AIC and the (sample size adjusted) BIC are not considerably smaller for the four-cluster model than for the three-cluster model, thus underlining the decision in favor of the less complex model. Furthermore, the three-cluster model has a higher quality of classification than the four-cluster model with average latent class probabilities of $\geq .89$. Figure 2 shows the distribution of the three clusters. It becomes obvious that besides the level differences, different priorities can be identified which characterize the three clusters.

**Table 3.**

Results of latent class analyses

| Number of cluster | AIC | BIC | Sample size adjusted BIC | Average Latent Class Probabilities |
|---|---|---|---|---|
| 2 | 12795.60 | 12934.96 | 12842.86 | $\geq .93$ |
| *3* | *12440.96* | *12652.41* | *12512.67* | $\geq .89$ |
| 4 | 12273.05 | 12556.59 | 12369.21 | $\geq .87$ |
| 5 | 12209.69 | 12565.32 | 12330.30 | $\geq .80$ |

Note: The cluster solution highlighted in italics is pursued further in this article.

Cluster 1: Comprehensive digital school management (34 % of all principals in the five countries): This cluster is marked by a high

probability of the principals making use of ICT at least once a week across all domains: For all activities, the probabilities are above 60 percent.

Cluster 2: Partial digital school management (55 % of all principals in the five countries): This cluster can be characterized by using ICT at least once a week only for management activities in a narrower sense. For four leadership and management activities that could be viewed as being more oriented towards the pedagogical part of school management, the probability that school principals will conduct them using ICT at least once a week is less than 50 percent: Prepare presentations, preparing the curriculum, use social media to communicate with the wider community and work with a learning management system.

Cluster 3: Rudimentary digital school management (12 % of all principals in the five countries): This cluster can be characterized by usage patterns that are focused on very few areas: Only for the activities 'communicate with teachers in the school', 'search for information on the internet', and 'communicate with education authorities', the probability that school principals will conduct them using ICT at least once a week is more than 50 percent.
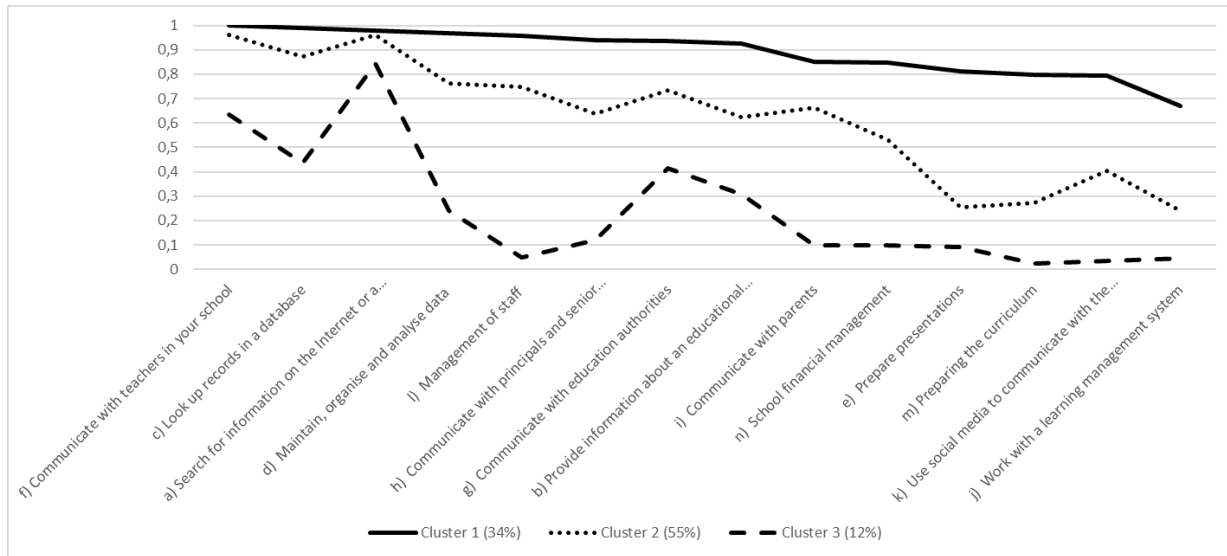
**Figure 2.** Distribution of the identified clusters

Table 4 shows the results for *research question 2*, indicating the proportions of principals who can be categorized into the three clusters. The extent to which the proportion per country differs significantly from the mean value is also calculated.

**Table 4.**

Distribution of principals across the clusters

| | Cluster 1 | | | Cluster 2 | | | Cluster 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **%** | **SE** | | **%** | **SE** | | **%** | **SE** | |
| Chile | 43.67 | 5.86 | ● | 41.83 | 5.81 | ▼ | 14.51 | 3.59 | ● |
| Denmark | 29.73 | 5.07 | ● | 68.46 | 5.00 | ▲ | 1.81 | 1.06 | ▼ |
| Germany | 22.31 | 5.20 | ▼ | 62.85 | 6.46 | ● | 14.85 | 5.88 | ● |
| Republic of Korea | 32.14 | 4.22 | ● | 49.59 | 5.24 | ● | 18.27 | 3.98 | ● |
| United States | 40.46 | 4.96 | ● | 50.49 | 5.60 | ● | 9.04 | 4.43 | ● |
| **Average** | **33.66** | **2.28** | | **54.64** | **2.52** | | **11.70** | **1.83** | |

Notes: SE – Standard Error; Significances in the percentages are calculated in comparison to the average frequency of each cluster.

● no significant difference to overall average; ▼ significantly lower
percentage than the overall average; ▲ significantly higher percentage
than the overall average.

The results for cluster 1 initially show that the proportion of school
principals in Germany who can be assigned to this cluster is
significantly lower than the average across the five countries. Only
slightly more than one-fifth (22 %) of school administrators in
Germany use ICT for leadership and management activities, which are
characterized by 'Comprehensive digital school management'. In
Chile, on the contrary, 44 % and thus the majority of the school
principals can be assigned to this cluster, as well as a high proportion
of school principals from the United States (40 %).

For cluster 2, it is clear that the proportion of school principals in
Denmark who can be assigned to this cluster is significantly higher
than the mean value (55 %). Almost 70 percent of school administrators
in Denmark perform leadership and management activities with ICT,
which can be described as 'Partial digital school management'. In
contrast, the proportion of school principals who can be assigned to
this cluster in Chile is significantly below the average (42 %). In all
other four countries, the largest proportion of school principals can be
assigned to this cluster.

Looking at cluster 3, it is clear that once again Denmark shows a
significant deviation from the average value. In this cluster, which is
characterized by a rather low, infrequent use of ICT, only a very small
proportion (approx. 2 %) of school principals in Denmark can be
classified. On average, the proportion in this cluster is 11 percent
across all five participating countries.

In regard to the *third research question*, the results show that when considering the five countries together there is no significant relation between the identified clusters and the average level of students' competence in CIL opting for a 95 percent confidence level. Similarly, there are no significant differences when the five countries are considered separately.

## Discussion and Conclusions

The results show that it is empirically possible to identify clusters of school principals' digital leadership and management activities (research question 1). Concerning the first cluster (*comprehensive*), there is a slightly lower probability of using ICT for presentations, preparing curricula, and working with learning management systems, suggesting that either these activities connected to pedagogical management are less frequent in the daily practice of principals or that ICT is less frequently used for these activities. In cluster 3 (*rudimentary*), the activity 'search for information in the internet' should be considered more specifically. One could argue that this is an activity that is part of everybody's everyday routine, and it might not be connected to school management. Then this group is only using ICT for communication with principal collaborators (teachers and authorities). Also it should be taken into consideration that there are some principals in this cluster who have started using ICT for basic administrative tasks connected to working with and communicating data and information.

Furthermore, we see variation in regard to the distribution of principals across clusters between countries (research question 2). For Germany, the result that the proportion of principals in cluster 1 '*Comprehensive* digital school management' is significantly below

average is not surprising, as ICT was not considered a priority at the
time of data collection. While there have been numerous developments
since then (see, e.g., German Federal Ministry of Education and
Research, 2023), it's doubtful that this situation has changed
significantly as principals in Germany are facing many challenges
which might lead to matters of ICT being relegated to the fringe. There
is a need for school principals to understand their new role to set
directions in schools when it comes to school leadership (Dexter, 2018).
Almost no Danish schools are in the cluster of limited use (*rudimentary*
digital school management), and the results thereby confirm that
Danish schools are highly digitized as it has been intended and
promoted in a number of Government initiatives during the last three
decades (Bundsgaard et al., 2019; Caeli & Bundsgaard, 2020).
However, the results also show that most Danish principals are not
among the cluster 1-respondents of *comprehensive* digital school
management. Thus, most Danish principals do not use ICT intensely
for a variety of pedagogical activities. This can be considered
somewhat surprising in view of the fact that Danish principals
historically have prioritized the pedagogical aspects of school
management and are encouraged to do so by the educational
authorities (Danmarks Evalueringsinstitut, 2006, 2017). In Chile, on the
other hand, where schools are equipped with different levels of
technology from region to region and are less well equipped with
software compared to other countries (Fraillon et al., 2020), principals
use ICT relatively regularly for various work tasks, which is reflected
in a particularly high percentage in the cluster of *comprehensive* digital
school management. This shows that the integration of ICT into the
day-to-day work of school principals depends not only on the
educational policy framework and the availability of resources, but

also on further country and school-specific differences that still require further research.

The analyses for research question 3 showed that the patterns of ICT use by principals do not have a significant impact on pupils' CIL in any of the countries studied. The comparison within Europe based on ICILS 2018 results (Fraillon et al., 2020) indicates that pupils in Denmark achieve significantly better CIL results than pupils in Germany. However, as this study shows, this cannot be explained by the use of ICT by principals, which also differs between the two countries. The results presented could either indicate that there simply is no significant relation between the ICT use pattern of principals and students' competence in CIL or that a possible link is mediated by various factors that were not taken into account in the context of this study. This would echo insights regarding the importance of context when trying to assess the impact of educational leadership. The ICILS Framework takes many additional factors into account. Future research around educational leadership research could therefore look into possible links between the activities of principals making use of ICT and those factors. Future research should also look more deeply into possible reasons why certain countries have school principals with such high usage patterns. Also looking into possible barriers to using ICT for principals appears to be fruitful.

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