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Dear "e-mentor" readers,

I am pleased to share with you the latest collection of papers, which brings us closer to the redefined scope of our journal: **higher education in management and economics**.

Readers primarily interested in business education trends can learn about the need for practical financial education at European universities. A study conducted in Romania, Poland and Spain reveals that students' financial literacy is influenced by socio-demographic factors, their academic background and work-related factors. The readers can also gain insight into the changes in the education process to raise interest in creativity and innovations in IT.

Inspiration can also be found in Sweden, particularly in the discussion regarding the potential adaptation of the Swedish model of surrogate student entrepreneurship in Poland. This issue covers other topics related to education, such as case studies as a research strategy in comparative education, maintaining a work-life balance among school teachers, and gifted students' communication with teachers.

The last two articles discuss new trends in management and economics. The first focuses on assessing the conditions for the development of the financial technology (FinTech) sector in selected countries. The second focuses on leveraging information and communication technology (ICT) for knowledge-driven agripreneurial innovations and advancing sustainable development goals in rural economies.

I hope you will enjoy exploring this issue. At the same time, I would like to cordially invite you to contribute to "e-mentor" and to support our efforts to internationalise the journal. Following an analysis of the results of the project financed by the Ministry of Science and Higher Education (Poland) completed in Oct 2024 (RCN/SP/0361/2021/1), we have decided to publish all articles in **English only**. Please be advised that from the beginning of 2025, there will be no further calls for manuscripts prepared in Polish. Furthermore, our goal is to make "e-mentor" a journal that serves as a forum for the presentation and discussion of research and ideas related to teaching and learning in management and economics higher education. We aim to provide a platform for the exchange of knowledge and insights on the use of technology in education, including e-learning, forms and methods of education, the verification of learning effects, and the integration of new trends in management and economics into higher education.

"E-mentor" is an open-access journal available free of charge, both online and in printed form. All scientific papers are peer-reviewed and we provide free proofreading of papers accepted for publication. Every article gets an individual DOI registered in Crossref, and the journal is indexed in several global databases, including Web of Science ESCI and EBSCO. There is **no publishing fee for the authors**. Further details are available online at http://www.e-mentor.edu.pl/eng/page/8/Info_for_Authors. Should you have any questions concerning publications in "e-mentor", please contact the editorial team at redakcja@e-mentor.edu.pl.

Małgorzata Marchewka
Editor

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Changes in the Education Process to Raise Interest in Creativity and Innovations in IT

Abstract

Rapid changes in society also require changes in education. Emphasis is placed on knowledge and skills, while modern society needs a broader perception of learning supporting key competences as a set of knowledge, skills, abilities, and attitudes for application in society. Information technology (IT) is key to the development of implemented processes and it is natural to think about the challenges for IT education. The purpose of this article is to explore new activities for learning IT that increase students' passion in IT and promote connectivism with an optimal competency framework based on measurable values of learning outcomes. Trust between a teacher and students and an open and creative environment in the classroom are essential for better results in IT education. IT has different variants of solutions and has a special impact on the search for optimal resources and methods using practical examples. The question is how to achieve optimal communication and organization of work while acquiring the necessary competences for the 21st century.

The method is based on a literature review and practical experience from teaching in a selected course focused on operating systems. The interest is in working in groups, diversifying tasks for seminars and surveys to support better communication, and in creativity and courage in learning. Data were obtained from surveys in which students answered questions, evaluated individual lessons, and specified topics for further assignments in which they would be interested.

Learning experiences and survey analysis show students' interest in variability in IT. The students' responses demonstrate their creative thinking, which is reflected in the diversity of implemented business plans, or in their deep understanding of IT processes. For teachers, it is about collaborating with students, and encouraging their curiosity by actively engaging them in the learning process. Communication was key to finding out more about students' preferences for showing advanced or student-inspired tasks, as well as providing assistance with complicated methods according to students' true needs. Students value freedom, cooperation, thinking about difficulties, or being able to create a plan for future business building using IT.

Keywords: education and learning, knowledge and skills, learning outcomes, information technology

Introduction

The focus of education is acquiring the necessary knowledge and having optimal skills for business practice. The main reasons for precision education include impact on society and support for change (OECD, 2025), with the future of education being shaped by current economic, social, demographic and technological trends. Another reason is the need for inclusiveness, progressiveness and support for changes at the level of society and economic development. For the modern information and global society that has evolved this century, it is a matter of supporting creativity and innovation leading to the stability of society (Trakšelys, 2013). Information and communication technology (ICT) is leading to changes in implemented processes, and artificial intelligence (AI) is causing enormous changes. Data is stored in databases, and IT users have

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to work with it correctly in the optimal format and time. The volume of data is large, and working with it is no longer intuitive. Again, this is a question of new knowledge and skills to use modern technologies.

Modern education addresses a wide range of issues related to the AI-designed approach (Hu et al., 2024), the construction of the teaching system (Yang, 2024), the competence of digital teaching (Shon et al., 2024), education reform and changes driven by digital technology (Wang et al., 2024), improving academic performance (Huang & Chen, 2024), interactive experience (Dune, 2024), impact on student creativity (Zhang et al., 2024), personalised framework in online learning (Amin et al., 2024), quality factors affecting e-learning (Bamaga et al., 2023), the role of educators (Li et al., 2024), support for sustainability (UNESCO, n.d.), usability dimensions (Akpinar & Yörük, 2024), use of ChatGPT in academic activities (Acosta-Enriquez et al., 2024), vision of education (Allman et al., 2024), or also evidence of zero knowledge in education (Xu, 2024).

The global information society co-creates social, cultural and political structures and norms that are associated with a given state or region. The functioning of society includes various aspects of life, values, traditions, and ideologies, but also the necessary technologies and institutions. An essential need of individuals and groups is the corresponding perception of knowledge and skills, which are created by active processes based on the active participation of the individuals. These knowledge and skills are supported by education in various forms. In the field of education, a number of theories have appeared that influence approaches to solving the necessary processes. This is a question of theoretical starting points and practical approaches to education to cause a better acceptance of learning by students regardless of age.

Approaches addressing behaviourism, cognitivism, connectivism, constructivism, and humanism have proven effective over time (National University, n.d.). And it is connectivism that represents the theory of learning for the 21st century. It is an approach that is useful for both students and educators. This approach is based on the use of technologies, which are an indispensable tool of education (learning) with regard to students of generation Z and the subsequent generations. The advantage of connectivism (360 learning, n.d.) is the interest in supporting the ability to search and filter information so that it is possible to conduct reliable research, and work in groups on assigned tasks. These activities combine technology with group and community interaction where learning outcomes help clarify specified expectations. Learning outcomes require systematic SMART access (Specific, Measurable, Agreed Upon, Realistic, Time-Framed).

The values of confidence, curiosity, and creativity for sharing an interest in new approaches and cooperation for practice are important for everyday education with students. From this point of view, the basic principles of connectivism learning theory contribute to effective education and learning (Siemens, 2005): learning and knowledge is based on a diversity of opinions (I), learning is a process of connecting information sources (II), learning may involve use of non-human appliances (III), the ability to know more is defining what is currently known (IV), connections need to be maintained to facilitate continual learning (V), the ability to see connections between disciplines, ideas, and concepts is a basic skill (VI), attaining current knowledge is the goal of connectivist learning activities (VII), and decision-making is a learning process (VIII).

The above-mentioned principles are the starting point for modern teaching of selected courses at the Silesian University in Opava, School of Business Administration in Karvina (SU SBA in Karvina). The topic of this article is changes in education for the 21st century in a selected course that focuses on IT as one of the key trends in the development of the information global society. In order to effectively address this topic (scientific question), a review of the literature was carried out to find out more about current approaches and theories. The necessary data and method were specified, and practical experiences from education (learning) were analysed supported by surveys from the selected course (Operating Systems course). The results were discussed and finally there is space for conclusion and references.

Education for a Creative Society

Society is based on a way of organising the common life of people in a certain place at a certain time. There is significant variability, and the changes are clearly visible. Contemporary society is postmodern, globalised, and informational. It is the next stage of development after the industrial society. The main sectors of employment include agriculture, industry, and services. Emphasis is placed on the processing and correct use of information in the information society (Castells, 2000; Mansell, 2009). Priority is given to thinking, emphasis on lifelong learning, and people's flexibility, which is reflected in the ability to learn new things. Information is important to society as a whole, and is a major strategic resource. IT is essential, and it is wonderful to assume that society will be like a great university for the creation of knowledge (Bell, n.d.; Bell, 1973).

Today's society values innovations and new approaches to solving existing processes. Knowledge from different perspectives is valuable for education to find more about the existing diversity. There is a particular interest in cooperation and connection to build relationships based on new ideas and innovations. It is natural to use applications, social networks and AI in the designed processes. A community of IT users is formed and IT users share their own experiences. This approach encourages developing knowledge and being more critical. A special requirement is the ability to learn this volume of knowledge in real time (Siemens, 2005). Such challenges require the ability to see connections between disciplines, ideas

and concepts. It is a learning environment that fosters a new learning opportunity based on human connection. Society is developing very fast, and it is natural that the current knowledge may change in the future. Thus, the knowledge gained will have to constantly evolve as new understandings emerge.

In relation to this reality, creativity is the central concern. Creative education is an essential key for the development of society. For example, a study by Adobe says that 82% of business leaders believe creativity is the most important skill for the future of work (Adobe, 2022). Creative thinking is important to prepare people (students) for new methods of making positive changes in the world. Creativity is based on the ability to create different opportunities in different ways. The topic of creativity is closely related to business and involvement in social challenges, related to the environment, for example. Getting involved and looking for different solutions is a way to develop creative and critical thinking.

In education, assigned tasks relate to accredited study programmes and courses according to syllables. These texts are more formal, but it is good when the teacher is able to create a space where creativity is encouraged due to the available time, so that *free play* has different results. For this time, the question is finding optimal resources and information, learning a suitable method of problem-solving, and practical examples of cooperation with others in learning groups. An important part of this way of teaching is encouraging students to ask questions, explore new things, and be open to different ideas between learning groups. Thus, curiosity is an important part of creativity (UKEssays, 2018) because creativity leads to innovations. An inspiring approach is evident in the pillars of the education model (Davidson & Goldberg, 2009; Davidson & Goldberg, 2010) to rethink learning and develop skills according to current challenges for education and university education. These pillars include a decentralised pedagogy, networked learning, open-source education, learning as connectivity and interactivity, or lifelong learning. The main concern is the promotion of collective learning, cooperation, and learning as a part of society and culture. Today's students learn to solve specific tasks by default, but new situations and challenges require the ability to adapt and improvise in responses and work methods.

Education for Information Technology

The development of the information society is based on the support of education and the constant addition of knowledge, professional flexibility and new possibilities based on the creative abilities of people, increasing the ability to respond to changes, new possibilities of applying cultural traditions, a qualitative shift in respecting ecological requirements and saving natural resources and the environment (Digital Future Society, 2022). Education plays a unique role in promoting access to knowledge and proven methods, but there is also an important interest in creativity and curiosity. This learning is like planting the seeds for a more creative society (Resnick, 2007). IT has great potential to help design implemented processes and process stored data, systematically supports innovation and creativity in society, and also needs creativity for its development and IT users' interest in better solutions.

IT development has close ties to mathematics and languages for the use of algorithms, and now it is only one step away from programming, modelling and simulations to find the optimal solution based on IT implementation. Again, the key to innovations is knowledge. Knowledge that provides control over implemented processes and data processing. It is not enough to just have knowledge, but thinking about how to do something and why is important in a rapidly changing society (Romeike, 2008). Early learning is all about browsing, clicking and chatting to learn more about a chosen topic. It is a special moment to browse the Internet for inspiration and interesting ideas. For working in groups, it is useful to specify the roles of the members of these teams, and thus communication skills are needed. It is not just about browsing, clicking and chatting on the Internet. It is necessary to support the ability to analyse the results obtained. This ability is about assessing the credibility of sources and their selection in terms of quality. The ability to analyse and synthesise the collected data is extremely valuable, as young people from Generation Z and other generations have significant problems with this (Majewska, 2021). The results of this approach have greater variability, and it is possible to try one's own unique way, to be inspired by another suitable solution, or to look for a way to modify it. The final step of this learning is the specification of a solution, which is verified and presented in learning groups (Center for Teaching and Learning, n.d.).

From the point of view of current trends, a set of knowledge, skills and attitudes is important for a person who acquires them to successfully manage tasks and situations (Šimek et al., 2024) in real life. The competency framework (CF) is made up of knowledge, skills and attitudes. Knowledge is an understanding of facts, information, and skills acquired through experience or education. It is a theoretical and practical understanding of a chosen topic, object, person, thing, idea or situation. Attitude is a summary assessment of the topic (subject) of thinking. Attitudes are perceived as self-confidence and responsibility to lead proactivity, toughness, and openness. Education is about willingness to learn and respect for sustainability. In practice, attitudes have a positive effect on commitment to lifelong learning, creative and innovative thinking, passion for technology, and willingness to collaborate.

A passion for IT may be manifested as the ability to demonstrate the implementation of a selected application in various ways and to be able to create new effective methods of implementation. IT has a large volume of proven methods and methodologies, but innovation requires creativity and is a deviation from the standards. The reason is natural, as better

results may be achieved differently in the future (Ginnis, 2002). The results of IT education related to attitudes, such as student's opinion on the topics being discussed, are specified as the competence to decide, think, summarise, and adopt (PO>STUDIUM, n.d.). The key to assessment is that learning outcomes (Bienertová-Vašků et al., 2016) may be created for each competency. The feasible tasks for demonstrating competence are shown in table 1.

Table 1
Feasible Tasks to Demonstrate Competence

Rank	Feasible task	Demonstrating competence
1.	creating	create a new result
2.	evaluation	defend the position (decision)
3.	analysing	find connections between ideas
4.	using	use information in new situations
5.	understanding	explain ideas or terms
6.	remembering	repeat the terms and facts

Source: authors' own work based on *The concept of creation and development of professional study programs* [Presentation], D. Šimek, T. Pražák, T., & M. Klepek, 2024, Silesian University in Opava, School of Business Administration in Karvina.

At the top of the list of feasible tasks is creating (1). This feasible task focuses on the creation of new results by formulation, design, development, compilation and further research. Evaluation (2) focuses on the process of defending one's own position by argumentation, estimation, assessment, evaluation or critical evaluation of the situation. Analysing (3) is about being aware of differences, looking at connections and contrasts, experimenting, expressing doubts, and verifying. Using (4) is about use, demonstration, and interpretation. Understanding (5) refers to description, discussion, explanation, reporting, and translation. The last on the list is remembering (6), which is repeating and specifying facts and terms. From an IT point of view, there is an interest in computer programming, consulting services and other related activities with a focus on analytical activities, data analysis, database management, software design, and testing. IT is one of the trends of modern society, and IT development has many advantages and challenges. There is also room for innovation, and AI is a more than attractive engine for future development. This reality needs new visions, advanced knowledge, skills, and an approach to designing using modern applications, systems and other tools. There is interest in an automatic solution for better IT support of IT user processes.

Data and Methods

This study uses a mixed-method approach that combines elements of quantitative and qualitative research to gain a more comprehensive understanding of the issue. The surveys contain both closed-ended questions (quantitative component) and open-ended questions (qualitative component). There are questions where students select numbers on a rating system, and others where they are free to provide detailed answers and opinions. Data for the analysis is obtained from surveys and practical experience with students on the Operating Systems course who study full time. These were standard students enrolled in the study, and a total of 75 studies were entered. The necessary data was collected from February 2024 to May 2024 based on ten surveys. The surveys were standardised to ensure uniformity of questions and the way they were presented to respondents, leading to comparability of results. The reason for this choice of method was to ensure that the surveys could be used by all respondents (students) and that the results were reliable. Specifically, the following requirements for consistent question format, clarity and unambiguousness, standardised instructions, and ensuring impartiality and neutrality were addressed. At the beginning of the work with each survey, the purpose of the survey was specified to make it clear what the survey was about. Normalisation of responses was supported by offering possible response options or a rating in the form of a scale, but many of the responses could be entered freely using a text field.

The Operating Systems course is an accredited course for the Managerial Informatics program (Silesian University in Opava, School of Business Administration in Karvina) taught in the summer semester 2024. Lectures and seminars are aligned with the course syllabus, which focuses on the operating system and its structure (1), operating memory and process management (2), peripherals and drivers (3), file systems (4), the service system and network environment (5), application programs and user environment (6), and security and monitoring (7). In the individual tasks, there is interest in active work in the selected Linux/UNIX operating system, graphical environment and terminal, requirements for automation, and possibilities of using AI. The practical tasks are divided into three parts, basic tasks for the topics taught according to the syllabus, advanced examples for inquisitive students, and topics based on the recommendations of the students as to what issues they would like to solve in the seminars. For each assigned task, instructional examples and solutions are available in the form of an operating system story, solved examples of operating system control, presentations, and project tasks; however, the concrete implementation by students is not limited to the demonstrated approach. On the contrary, initiative and other solutions, with an analysis of possible advantages and disadvantages, are welcome in learning.

Surveys were available to students throughout class time during the semester. The surveys were devised by the teacher of this course. The primary goal of the question blocks was to support understanding of IT (key concepts, useful ideas) to lead to the use of IT for new situations based on the connections between ideas. The surveys provided feedback using

questions for motivated active work, thinking about the discussed topic and cooperation in groups. This communication is highly appropriate, because anonymous access breaks down barriers, and reduces fears of possible punishment for an inappropriate answer. Some students had a negative experience with education, and prefer this method of communication. From a teacher's perspective, there is an optimal way to create a creative environment for sharing ideas in the classroom. A positive approach is taken by specifying topics for reflection based on the recommendations of the students as to what they would like to address in the seminars. These topics include running a Windows Server (such as Windows Server 2022) using virtualisation (VMware Workstation Player) or using the cloud using Microsoft Azure, practical monitoring services and running a Windows Server image, or comparing the performance of a selected Linux/UNIX image with Windows performance where virtualisation is running. Two innovation seminars were specifically focused on the application of IT in business and the use of AI. The innovation consisted in connecting operating systems and application hosting through implemented processes in business and after thinking about one's own business plan. Selected questions with answers from the ten surveys are available in tables 2, 3, 4, and 5.

The above-mentioned communication with students is evidence of students' interest in IT and operating systems. Some answers need correction, but it is a good reason for the teacher to focus more on practical work in the specified topics. This moment leads to a discussion. It is a great learning moment,

Table 2

Surveys from the Operating Systems Course, Selected questions about Working Methods in the Linux/UNIX Operating System

Selected questions from surveys	Students' answers
Where and in what file is user account information stored in Linux/UNIX operating systems?	/etc/passwd; usr/bin/psswd; passwd; files – User or bin – bash; etc/passwd and etc/shadow
What is the structure of the /etc/passwd file?	username:password:UID:GID:GECOS:home_directory:login_shell; has a structure with one record per line; name, password, UID, GID, full name, home folder, shell; it is a text database that contains information about all user accounts on the system; each line in the /etc/passwd file represents one user account and contains seven fields separated by colons; „."
Where are the files available for the Apache web server?	subdirectory apache2; directory /lib - drwxr-xr-x 3 root root 4096 Feb 25 10:43 apache2; /etc/apache2; computer/etc/apache2; /apache2
What is the meaning of directories rc3.d a rc2.d?	scripts that run when the computer is turned on; contain symbolic links to startup scripts that are used when switching to the appropriate runlevel; each runlevel represents a certain state of the system in which certain sets of services and processes are running

Source: authors' own work.

Table 3

Surveys from the Operating Systems Course, Selected questions about Experiences with Operating Systems and Course Expectations

Selected questions from surveys	Students' answers
What affects the development of operating systems?	software development, user requirements; hardware development; IT trends, innovation and development (currently mainly AI, windows copilot), competition; market competition, standards and regulations; open-source code; time, money, access
What operating systems do you have experience with?	Windows, Android, iOS, Windows (8, 10, 11); some answers were about Mac OS, Ubuntu
What would you change in your operating system?	increased speed, higher performance; greater possibility for modification; greater variability in iOS; customising some elements and making it free; nothing yet; I am satisfied with it; probably nothing
What do you expect from the Operating Systems course?	get better and better at working with operating systems and user account creating for different users; improving knowledge in this area, introduction to the issue of operating systems; learning the differences between systems and their control; ability to understand more about operating systems and how exactly they work; getting to know new operating systems and working with operating systems; I don't know, it will teach me to navigate the world of technology; the possibility of exploring other operating systems that can be used in future works; I will learn something new, because I don't have much knowledge in this direction

Source: authors' own work.

Table 4

Surveys from the Operating Systems Course, Selected Questions for Advice on Another Topic for Learning and Evaluation of Learning from the Students' Perspective

Selected questions from surveys	Students' answers
Indicate a topic for practical work in the seminar. What did you miss, or what would you like to continue to do?	Windows server; I learned everything important; everything is okay; I am looking forward to the next lessons, where I will learn more advanced things; I lacked nothing; I didn't miss anything; how to work in Kali or other system
Was the topic of the user account and its environment sufficiently presented for you? Would you welcome any further clarifications?	everything clear; I would welcome more hands-on work with accounts; sure yes – it was harder at first but then good; perfect – it was sufficiently presented for me; more emphasis and describe in more detail each command and what we can find out/do with it; yes, it would be better to discuss it in depth
Indicate a topic for practical work in the seminar. What did you miss, or what would you like to continue to do?	application development and functionality; creating an SQL database using a Windows server; an example from practice of how companies use other operating systems and why they use them (pluses and minuses); nothing comes to mind; I don't know; analysis of technologies used by large IT companies
The topic of file systems will also be addressed at the next seminar. What would you like to focus on?	that archiving; faster file data optimisation; I would like to know more about the systems used by Linux; I do not understand that; I have no idea; I don't know; I don't quite understand it, but I try; „."
How are you meeting the expectations of knowing how to manage Linux/UNIX operating systems?	8/10; I know everything we do; I still have to repeat the system monitoring; I'm glad that we cover the subject with this teaching style
Advanced examples are part of the tasks in the seminars. Is the selection of these tasks optimal?	7/10; the tasks are difficult at first glance, but they can be mastered; is optimal; yes they are sufficient; yes, it is optimal

Source: authors' own work.

Table 5

Surveys from the Operating Systems Course, Selected Questions about Practical Work Related to a Business Plan to Reflect on Appropriate IT Integration, and Operating Systems too

Selected questions from surveys	Students' answers
What topic have you chosen for your intended business plan with regard to addressing hardware and software requirements?	streaming platform; start-up cafes; 3D printing company; video game company; drone food delivery company; (Droonora) – an e-shop for the sale of garden tools; baby connect a wristband for newborns or even older children to control their bodily needs via a mobile application; an automatic coffee shop with selected coffee; an AI doctor connected to the distribution of medicines
If you worked in groups, what roles did you assign to individual members?	speaker, researcher, writer, project manager; division into hardware and software; manager and cook; marketing manager, support manager, project manager; one processes orders, the other manages the e-shop, the third packs orders; graphic artist, programmer, marketer, game writer, designer, music; CEO and master
What was difficult in solving the task?	choosing a set topic; big and established competition; food storage and shelf life; creation of an application to pair a finance drone; agree on a start-up topic; distribution; necessary budget for IT; capital and technology; time, finding qualified people, finances
What was easy to solve in the given task?	selection of software; selection of software and hardware; a wide range of customers; workflow; idea, division of roles; hardware devices that we need for the company
What limited you when choosing a solution to the assigned task?	topic selection based on software and hardware requirements; budget; low number of ideas; lack of knowledge of technology; little selection of optimal creators; finance and space for implementation; prices, time
What do you value about your work in this innovation seminar?	freedom; cooperation; group work; the possibility of thinking about the difficulties of starting a company in the group (achieving consensus); I could make a plan for the future business building; communication with each other; we do what we like

Source: authors' own work.

because the discussion is about thinking about how to perform processes better. Some answers are without expressive ability. These are answers of the type ".". The surveys also show the students' journey from simple tasks (user environment) to more complex ones (website or database server administration or using the command line). At the beginning of the lessons, only some students tried the advanced task, but over time they became more confident and were able to solve even the advanced tasks. One of the answers accurately reflects the experience with these tasks: the tasks are difficult at first glance, but they can be mastered. Sometimes students asked about more advanced issues, more hands-on work, or more detailed description of mentioned commands. On the other hand, they also asked for help on a complicated topic, such as file systems. This communication had a positive effect on learning, as the teacher was able to give advanced and gifted students more space, but it is also important to create space for repetition and working with advanced methods for setting up and monitoring operating systems.

Results and Discussion

The results show that learning helps students create their own way of understanding the chosen topics, proceeding step by step with interest, and confident that they are able to achieve their own goals. Communication has been the most important thing in learning, and integrating survey into teaching has unique benefits. Students have the opportunity to have a say about ideas and what they want to do in learning. This approach is singular, because it tries to combine business plans with the topic of the chosen course. From the teacher's point of view, interesting ideas and suggestions from students regarding the integration of IT, including operating system support, into business plans related to start-up cafes, 3D printing companies, drone food delivery companies, or a bracelet for newborns to monitor them using a mobile application. The last business plan was created using IT in detail. The idea of using drones in business was closely tied to AI, which is a key trend of IT development. This reality in education creates better IT support for business and everyday use of IT by students.

There is a meaningful space for monitoring the perception of the study material discussed in learning outcomes. Students are free to ask for help without being concerned about a bad grade. They also have the opportunity to compare opinions with others, and in many cases this fact leads to the topic being discussed. They confirm that everything is clear, they want to have further advanced examples, or they state that they need to repeat the topic again. This is an indispensable moment for learning, because feedback is essential. There was a shift from initial embarrassment to the possibility of mutual discussion on the solved examples, and a greater interest in teaching was shown. This situation is visible in addition to the suggestions of topics such as Windows server, Kali, or a different operating system, creating a web server, and working with the command line. Some of the suggested additional topics were part of the course, but more time could have been devoted to detailed setup of Linux/UNIX operating systems.

The following lines generalise practical knowledge and experience from teaching the Operating Systems course for a better understanding of the process of such teaching. Educational activities (EA) are specified in a manner similar to the function of activities such as lectures (L), seminars (S), and tasks (T) with a focus on basic, advanced and student-inspired, and communication (C) innovatively oriented towards survey communication and communication in teams, and also other types of communication according to student preferences, based on the Teams application from Microsoft, the information system (IS) of the university and, of course, traditional personal communication by words. There is the formula:

$$EA = f(L,S,T,C) \quad (1)$$

When weightings are added to each element of educational activities to monitor its educational importance, then this formula is:

$$EA = w_L L + w_S S + (w_{Tb} \bullet SE)T_b + (w_{Ta} \bullet SE)T_a + \\ + (w_{Ti} \bullet SE)T_i + w_{Cs}C_s + w_{Ct}C_t + w_{Co}Co \quad (2)$$

where L and S are the number of lectures and seminars, T_b,T_a,T_i are the numbers of basic, advanced, and student-inspired tasks, and C_s and C_t indicate the intensity of communication through surveys and teamwork; C_o is for all other types of communication. SE is a factor representing student engagement in the survey and teamwork through feedback, and the symbol w is for weightings that specify the importance of each item. If the CF is made up of knowledge, skills and attitudes, then optimal education requires maximising (EA) to achieve the corresponding CF with links to measurable learning outcomes, so that:

$$CF = f(K, S, A) = max\ (EA) \quad (3)$$

where K represents the volume of knowledge, S represents the volume of skills, and A represents the volume of attitudes.

Evaluation of learning in education is a well-known topic of many conferences and articles. Conferences such as the 6th Barcelona Conference on Education (BCE, 2024), and the 12th European Conference on Education (ECE, 2024), in London, or the 16th Annual International Scientific Conference, Theoretical and Practical Aspects of Distance Learning, (DLCC, 2024), in Cieszyn, show that the real interest is in education and difference, experiences of students and teachers, learner diversity, learning difficulties, lifelong and distance learning, student learning or theories and methodologies. Well-known articles explore the issue

of adaptive learning in university students' opinions (Smyrnova-Trybulska et al., 2022), methodological and technological aspects of using automated programming (Zielosko et al., 2022), happiness levels of students (McKay et al., 2022), or also educational and ethical aspects of AI (Smyrnova-Trybulska et al., 2023) and lifelong learning as a factor of innovative potential (Kuzior et al., 2023). Modern trends in education at universities are focused on technology, discussion, and problem-solving methods, but there is also an emphasis on communication, friendliness and humanity. It is important for universities to have the courage to take an interest in interdisciplinary research and to support groups of students with an active approach to innovation. Such learning is about quality, variability in approach, and internationalization to prepare students for practice with advanced skills.

This study involves surveys and draws on insights gained from lectures and seminars. This method is widely accepted. Similar studies use techniques such as topic-specific analysis within a master's program in information systems (Kurnia et al., 2024) and qualitative feedback collection (Haerawan et al., 2024) to assess how interactive videos can increase student engagement in online learning. Data envelopment analysis procedures (Munteanu & Aldea, 2024) are also used to assess teaching effectiveness in 40 European universities focusing on information technology and communication. Other approaches include the use of interactive simulations and formative assessments through online content (Wijenayake et al., 2022), mixed research methods that integrate standardized assessments with qualitative feedback (Khan et al., 2025), and the use of the Vevox platform for data collection (Zeidan & Young, 2024). Findings from this recent study highlight the effectiveness of group work, simulations and educational videos in increasing student engagement, enjoyment and focus. In terms of future initiatives to support innovative approaches in IT lectures, it is noteworthy that the interventions led to increased interest and greater concentration among students. Further insights can be drawn from research examining the impacts of education system reforms on student learning outcomes (Khan et al., 2025), where formative assessment highlights the need to implement changes aimed at increasing student academic performance. Both quantitative and qualitative improvements in performance, in which all relevant stakeholders play a part, are essential.

Conclusion

This article addresses teaching changes in IT-focused courses with practical experience from an accredited IT course focused on operating systems and their structure. The method employed is based on a mixed approach, and this approach combines elements of quantitative and qualitative research. Specifically, it is a series of surveys with closed and open questions. The closed questions represent quantitative components, and open questions relate to qualitative ones. This feedback monitored the current development of students' knowledge and skills for practical work with operating systems, and understanding of the necessary terminology. A place was created for individual tasks for students with advanced knowledge according to their preferences, to share with others their passion for IT and to encourage students to think creatively. For this reason, practical tasks in seminars were divided into basic tasks in the topics on the syllabus, advanced examples for curious students, and topics according to student recommendations. These tasks operate simultaneously in teaching and develop communication with students.

Communication in the classroom took place without any concerns from the students through surveys aimed at obtaining answers in front of the teacher, and group work was supported. The benefits are visible in the communication and diversity in the learning method due to students' individuality. At the lectures and seminars, the diversity of approach, and cooperation in individual groups and also between them, was visible. The value of such learning for students was in freedom, cooperation, and thinking about a start-up or a business plan integrating the implementation of different IT. For practice, there is a focus on more critical thinking and the ability to learn continuously. It is seen that the students' journey ranges from simple tasks, such as the user interface, to more complex ones, such as managing a website or database server and using the command line. The working environment in the classroom is well characterized by a statement made by a student, that the tasks are *difficult at first glance, but they can be mastered*. From the point of view of IT education, this reality requires a CF made up of knowledge, skills and attitudes based on learning outcomes supporting work in groups and diversifying tasks to find variability in IT implementation.

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Agnieszka Skala-Gosk

The Surrogate Student Entrepreneurship Model – Can the Swedish Commercialisation Model Work in Poland?

Abstract

Over the past twenty years, a surrogate student entrepreneurship model has been developed and practiced at the Chalmers University of Technology in Gothenburg, confirming that involving suitably prepared students in managing technological spin-offs can overcome key barriers to cooperation between universities and businesses. This paper discusses the Swedish model of surrogate student entrepreneurship in the context of its potential adaptation in Poland. The concept of the entrepreneurial university is explored, and a model-based framework for entrepreneurial university activities is proposed, depending on the level of benefits from commercialization and the degree of stakeholder engagement. The Swedish experiment may represent a promising alternative in light of the unsatisfactory indicators of knowledge and technology commercialization achieved by Polish universities.

Keywords: commercialisation, surrogate entrepreneurship, spin-off, entrepreneurial university, technology transfer

Introduction

The 'entrepreneurial university' concept is attractive from a research perspective. However, its body of knowledge remains fragmented (Cerver Romero et al., 2021; Guerrero et al., 2024). Entrepreneurial universities commercialize innovative solutions by transferring them to enterprises, which stimulates economic resilience both at the regional and national levels (Bristow & Healy, 2018; Celebioglu & Brenner, 2024), with cooperation between academia and business supporting the development of an economy-resilient to risks and shocks (Allard et al., 2012), and effective commercialization models at universities constituting a starting point for such processes. For four decades, there has been a debate over whether an ideal entrepreneurial university model exists or whether a variety of solutions should be adopted depending on local conditions (Philpott et al., 2011). Typical university activities within the scope of their entrepreneurial mission include patenting, licensing, incubation and acceleration, and in other cases, seed investments and the establishment of so-called spin-off firms[1].

Sweden is testing pioneering innovation commercialization models at its universities, which involve academics as 'providers' of new solutions and leverage students' potential to manage spin-offs operationally. In this model, referred to as the student surrogate entrepreneurship model, appropriately educated and trained students – so-called surrogate entrepreneurs – work in teams on real business projects assigned to them by researchers as part of their master's studies in management. The researchers are unwilling to become operationally involved in developing businesses based on their ideas and work, with the students taking full responsibility for making decisions to transform the best ideas into fast-growing enterprises (Lundqvist, 2014).

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[1] A spin-off (alternative spelling: spinoff) is a new enterprise established based of knowledge and solutions developed in the course of research conducted at universities and scientific research institutions (based on Matusiak, 2008, p. 15).

The starting point for the work discussed in this paper is the research question: Can the student surrogate entrepreneurship model developed at Chalmers University of Technology be effectively adapted to the conditions of Polish universities, particularly technical ones? The scientific aim of this paper is to present a case study of a unique commercialization model based on student surrogate entrepreneurship, developed and implemented by Chalmers University of Technology in Gothenburg, with the utilitarian aim of analyzing this case being to assess the potential for adapting the Swedish model to the conditions of Polish technical universities (or other research institutions).

The paper outlines typical activities undertaken by entrepreneurial universities, identifying the main barriers and success factors before presenting the student surrogate entrepreneurship model implemented by the Chalmers School of Entrepreneurship and its outcomes. The paper concludes with reflections on the possibilities of adapting the Swedish model to the Polish context.

Activities Undertaken by Entrepreneurial Universities

The idea of the entrepreneurial university has evolved towards viewing it as a 'natural' incubator supporting entrepreneurship, innovation, and sustainable development within the university community (e.g., students, alumni, staff, and academic teachers) and beyond through civic engagement (Guerrero et al., 2024). A holistic understanding of entrepreneurial universities highlights not only formal entrepreneurial activities such as technology transfer, incubation, or acceleration but also informal factors, including the attitudes of lecturers and students, entrepreneurial culture, and motivational systems (Kirby et al., 2011; Klofsten et al., 2019). These formal and informal elements can be regarded as academic intrapreneurial capabilities (Klofsten et al., 2021).

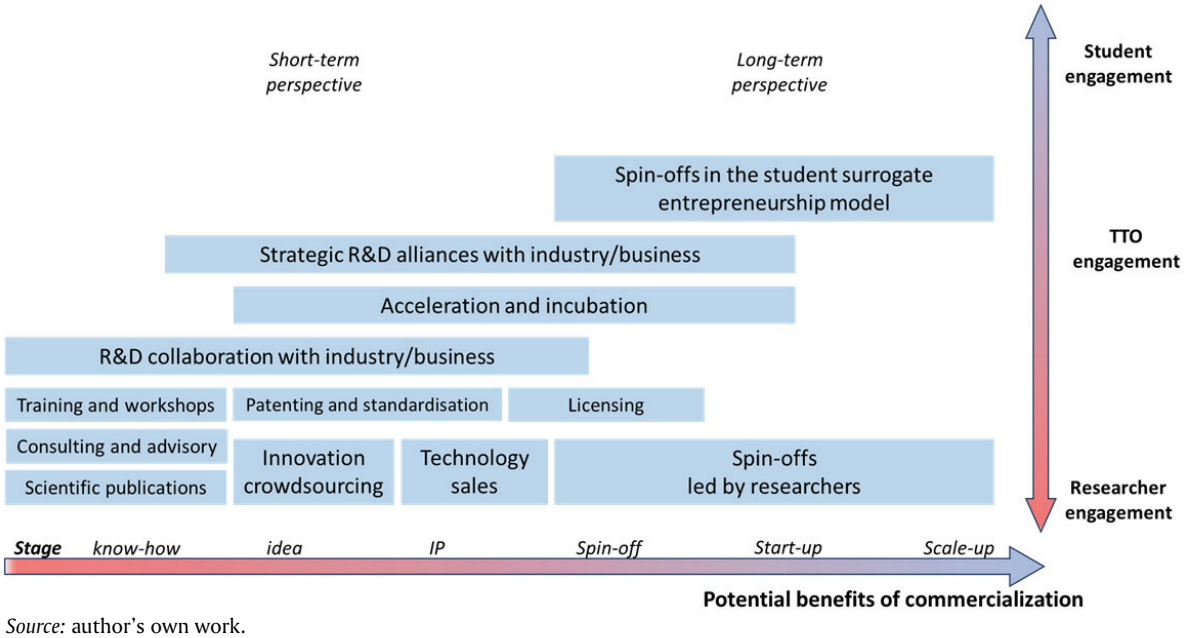
A substantial body of research has been devoted to various commercialization activities: technology transfer (Good et al., 2019), incubation (McAdam et al., 2016), academic entrepreneurship (Hayter et al., 2018), and entrepreneurship education (Hägg & Kurczewska, 2021), although these discussions rarely consider the possibility of synergy among these activities—for example, when technology transfer could simultaneously serve as entrepreneurship education (Lundqvist, 2014; Rasmussen & Sørheim, 2006), or when entrepreneurial education contributes to research and scholarship (Kyrö, 2018). Nevertheless, such combinations are particularly valuable for universities.

Figure 1 presents a model-based perspective on various entrepreneurial activities undertaken in pursuit of a university's entrepreneurial mission, which is considered about three main variables: the scale of potential commercialization benefits, the level of academic staff involvement, and the degree of student and/or technology transfer office (TTO) engagement. The following types of activities are included:

- academic publications, which disseminate scientific know-how (Walsh & Huang, 2014),
- consulting and advisory services, where academics offer business services that enable the implementation of new technologies or process improvements (Perkmann et al., 2021),

Figure 1

A Model-Based Perspective on Third Mission Activities Depending on the Scale of Commercialization Benefits and the Degree of Stakeholder Involvement



Source: author's own work.

- training and educational workshops that facilitate the transfer of know-how to industry (Borman et al., 2024; Politis et al., 2024),
- innovation crowdsourcing, where both universities and enterprises use crowdsourcing platforms to address research and development problems (Lenart-Gansiniec, 2022),
- technology sales (Kim et al., 2019),
- patenting and standardization (Ashari et al., 2023; Walsh & Huang, 2014),
- licensing (Shen et al., 2022; Wu et al., 2015),
- research and development (R&D) collaboration, where research institutions work with businesses on joint projects (Perkmann et al., 2021),
- acceleration and incubation, where universities support venture development through technical, advisory, educational and financial assistance (Clayton et al., 2018; M'chirgui et al., 2018),
- strategic R&D alliances, in which academic units and businesses form partnerships to develop intellectual property (Bercovitz & Feldman, 2007; George et al., 2002),
- 'classic' spin-offs run by academic staff (Wennberg et al., 2011), as well as those based on non-academic teams (Boh et al., 2016), including the model discussed in this paper (Lundqvist & Williams-Middleton, 2017; Lundqvist & Williams-Middleton, 2024).

Particular attention should be placed on the creation of spin-offs within the student surrogate entrepreneurship model, with research into academic entrepreneurship in Sweden and the United States showing that student surrogate entrepreneurs can help to overcome tensions between academic research activity and entrepreneurial involvement (Lundqvist & Williams-Middleton, 2013). In the cases studied, involving students as surrogate entrepreneurs enabled a greater number of business experiments and reduced the risk of conflict between academic and business cultures (Clarysse & Moray, 2004), with students testing the role of entrepreneur alongside their studies perceived as benefitting from support in learning to manage multiple identities (Raible & Williams-Middleton, 2021). Studies have indicated that too little attention is devoted to the role entrepreneurship can play in the educational mission of universities—and vice versa (Lackéus et al., 2016; Schmitz et al., 2017).

Main Barriers to Academic Commercialisation

The commercialization models used by universities, particularly technical institutions, are influenced by several key factors, the two most important being the approach to intellectual property (IP) management (Kenney & Patton, 2011) and the overall quality of services provided by technology transfer offices (TTOs). Faccin et al. (2022) described a typical conflict between TTOs and researchers, where TTOs prioritize IP protection through patenting (a standard measure of their performance), while researchers achieve career success through publications that may disclose the same IP. Guerrero et al. (2024) call for stronger mechanisms to support entrepreneurial mindsets across the university community, including students, academic teachers, researchers, and administrative staff. Kirby et al. (2011) highlighted the 'classic' conflict between entrepreneurial activities and universities' educational and research goals and promotion systems that are often unsupportive of commercialization.

Another barrier to effective university commercialization is limited access to private funding sources (Munari et al., 2018). Meek and Gianiodis (2023) examined key determinants for the activation of financial instruments by universities, among which the quality of acceleration and educational programs provided by universities (and hence by TTOs) emerged as a significant factor in ensuring credible validation of business concepts, proving a significant conclusion in the context of the surrogate commercialization model discussed in this paper.

In summary, the success of commercialization models at European universities is primarily shaped by the varying benefits for different stakeholders, the level of engagement of the academic community, the availability of funding sources, the legal framework for intellectual property protection, and the activity and capacity of technology transfer offices. The diversity of these challenges and opportunities and additional differences between commercialization models at technical and non-technical universities highlight the complex landscape of knowledge and technology commercialization in the European academic context.

Methodology

This paper adopts a cognitive-analytical approach based on a case study of the model implemented at the Chalmers School of Entrepreneurship. The choice of the method comes from the need for an in-depth understanding and representation of the complex phenomenon of student surrogate entrepreneurship, both in its organizational and institutional dimensions. At the same time, the case study enables a portrayal of how specific educational practices and knowledge commercialization mechanisms operate within one of the most advanced academic entrepreneurship ecosystems in Europe.

The model description is based on a review of the academic literature and internal materials from the Chalmers School of Entrepreneurship and repeated direct observation, including participant observation conducted by the author during a research stay at the institution in 2025. Additionally, in June 2023, an in-depth interview was conducted with Professor Karen Williams-Middleton, a leading scholar and coordinator of the entrepreneurial track at the Chalmers School of Entrepreneurship, serving as a key source of insight into the internal workings of the model under discussion.

The analysis aims to assess the model's potential for adaptation to Polish conditions, considering factors such as the legal framework (including intellectual property), institutional readiness of universities, resource availability, and the attitudes of key stakeholders – students and researchers.

The Student Surrogate Entrepreneurship Model at Chalmers[2]

Chalmers University of Technology (hereafter referred to as 'Chalmers') is Sweden's second oldest and second largest technical university[3], located in Gothenburg. As the country's second-largest city, Gothenburg has a strong tradition of commerce and industry. It is home to major corporations such as Volvo, Stena Line and SKF[4], each of which Chalmers maintains strategic partnerships.

In 1994, Chalmers was transformed from a state university into a foundation-based institution, with the operational flexibility enabled by this transformation allowing for the creation of new structures and mechanisms to support entrepreneurship, including the co-founding of Sweden's first university-based venture capital firm (1994), the establishment of its seed fund (1998), an incubator (1999), and the School of Entrepreneurship (1997).

The latter – Chalmers School of Entrepreneurship (hereafter referred to as 'the School') – was founded on the premise that entrepreneurial competencies are the primary 'bottleneck' in successfully developing university-originated ventures. The School brings together entrepreneurial master's students and promising ideas that lack managerial driving force, aiming to create competitive and sustainable ventures and educate capable entrepreneurs and entrepreneurial employees. Over the years, many iterations of its proprietary educational program have been tested, with the Chalmers School of Entrepreneurship today recognized as the leading startup environment in Sweden.

Educational Programme at the Chalmers School of Entrepreneurship

The key to Chalmers' commercialization success lies in using surrogate entrepreneurs recruited from among the School's students, combined with openness to ideas from various environments, including corporations. The School offers a two-year master's program leading to a Master of Science (MSc) in Entrepreneurship and Business Design.

Students can choose from three available paths within the program: Corporate Entrepreneurship, Intellectual Capital Management, and Technology Venture Creation. Spin-offs are developed at Chalmers within the latter based on the student surrogate entrepreneurship model.

Applicants

Applicants must hold a bachelor's degree. Around 30 students are admitted each year. There is no ideal candidate profile, as the goal is to create three-person project teams with diverse skill sets, with the first six months of the program serving as a period for students to get to know each other, followed by a matching process conducted by the School to form the teams.

On the other hand, researchers express interest in transferring intellectual property they have developed into future enterprises, as they are not interested in becoming entrepreneurs themselves, having committed to academic careers, but want to give their work a chance to reach the commercial market, which is their motivation. The belief that researchers prefer to remain researchers rather than engage in business is one of the fundamental premises of this model.

Curriculum

The introductory semester includes three integrated compulsory courses[5] for all participants: *Intellectual Property Strategies*, *Designing Technology Innovations and Markets*, and *Technology-Based Entrepreneurship*, with lectures taught. In the second semester, exercises and group tasks are introduced based on case studies, although they do not yet involve real-life projects. During this period, student teams are formed, familiarising themselves with the ideas submitted by researchers and ranking them according to their interest in working on them. Forming student teams and their 'pairing' with researchers' ideas is a lengthy, multi-week process.

The second year of study is dedicated to incubation[6], during which students learn through participation in venture creation, with the School providing additional skills and offering tools that support the validation of the business idea. In this way, the program increases the likelihood of terminating non-viable projects early—before the venture

[2] The model description draws on a review of the literature and internal materials from the Chalmers School of Entrepreneurship, as well as repeated direct observation, including participant observation by the author and an in-depth interview with the head of the ChSoE, Prof. Karen Williams-Middleton, held in June 2023.

[3] The oldest and largest technical university, the Royal Institute of Technology in Stockholm (KTH), was established in 1827, just two years before Chalmers.

[4] SKF is a Swedish enterprise and the world's largest manufacturer of rolling bearings.

[5] This means the student has no other coursework.

[6] According to Przybył and Grudzień (2011): 'Incubation is a service supporting the survival of a business during its initial phase—from its establishment to its third year. The service involves renting office space by the incubator on preferential terms compared to market rates.' The rental often includes accompanying services (e.g., accounting, etc.) (pp. 189–190).

capital investment stage (for example, from Chalmers Ventures)—focusing its efforts on promising, well-founded concepts that are more likely to attract venture capital funding. Students must terminate a venture and take on a new assignment if it proves unfeasible or unprofitable.

The entire second year is dedicated to a real-life venture project and the master's thesis, which is intellectually integrated and aligned. From the student's perspective, the program is an opportunity to gain practical experience in running a technology venture and to develop entrepreneurial competencies in a setting characterized by real market risk.

Ideas

Ideas originate from researchers or external partners—such as researchers from other universities or institutions and private individuals. The School and the incubator recruit ideas that must meet the program's educational requirements, which are:

- a strong technological component (i.e. deep-tech),
- potential for a scalable business model[7],
- international commercial potential,
- clear investment potential,
- sufficient maturity for students to identify its market potential within one year,
- backing from the originators, who hold the intellectual property and are willing to transfer it to a newly established company.

Intellectual Property Protection and the 'Professor's Privilege'

In Sweden, so-called 'professor's privilege'[8] applies, meaning researchers retain ownership of all intellectual property (IP) resulting from their research. In other words, the researcher's rights to an invention belong to the researcher, even if the invention was developed within the university under an employment contract. This concept simplifies commercialization, eliminating the initial researcher–university conflict over IP ownership. Partly for this reason, Sweden's approach to commercialization generally emphasizes stimulating academic entrepreneurship through incubating new ventures (spin-offs) rather than developing technology transfer offices.

The dialogue regarding intellectual property with the idea originator is conducted through a separate unit at Chalmers: the Innovation Office, which is, in some respects, the equivalent of a technology transfer office and supports the identification and acquisition of innovations across the university. Researchers are then directed either to the incubation process—if they are willing to be actively involved in commercialization—or to the School of Entrepreneurship—if not.

Commercialisation Process

The School of Entrepreneurship oversees two processes: team building and venture building. Operational teams consist of three students, and are connected with the scientific team—for instance, a researcher who provided the idea.

In the first phase, all parties involved define their roles in the emerging venture, with the idea providers initially signing a letter of intent, the students signing a non-disclosure agreement (NDA[9]), and finally, both parties agreeing and signing a cooperation agreement. During this phase, Chalmers' incubator provides financial support and assists in the further development of the projects. The incorporation of the venture can occur due to various events—for example, a paying customer, a significant investment, or the acquisition of a patent. The cooperation agreement is structured so that if either party decides to terminate it, the intellectual property returns to the original rights holder (e.g., the researcher).

The structure of the student surrogate entrepreneurship model developed at Chalmers is presented in Figure 2.

The model is designed to eliminate unpromising projects as quickly and decisively as possible, based on three main reasons:

- researchers incorrectly declare their willingness to collaborate, but, in reality, are not committed,
- the technology, although initially promising, turns out to have limited potential—for example, a researcher develops a technology for personal use, but the resulting product proves too niche to scale commercially,
- the level of competition is too high, as many people worldwide are working on the same problem, and someone else already reached the market earlier.

Commercialisation Outcomes in the Student Surrogate Entrepreneurship Model

It is estimated that ventures launched within the Chalmers innovation ecosystem account for around 15% of all startups in Sweden and generate over 40% of total revenues from university-incubated enterprises—giving Chalmers a leading position in the country.

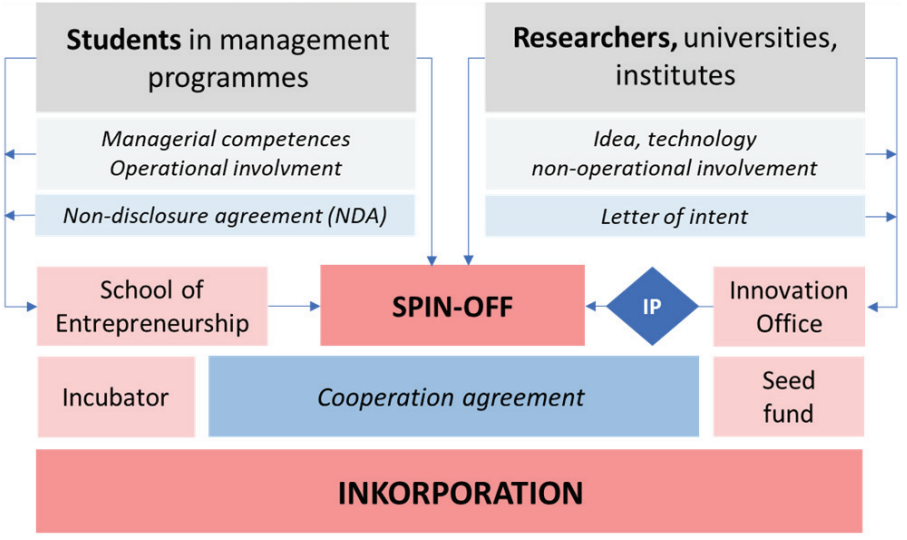
Over the past 20 years, the program has created approximately 140 companies—3–4 per semester on average. The survival rate of these startups is high: around 70% of the companies established through the program are still active, which is a significant figure considering the inherent risk of the startup environment. These ventures span various high-tech sectors, with many attracting venture capital investment.

[7] According to Osterwalder, a business model is the rationale for how an organization creates and delivers value to the customer and monetizes it (Osterwalder & Pigneur, 2010).

[8] For more, see e.g., Trzmielak et al., 2016, pp. 24–26.

[9] A non-disclosure agreement (NDA) is a contract to maintain confidentiality (Bądek, 2019).

Figure 2
Diagram of the Student Surrogate Entrepreneurship Model Developed at Chalmers School of Entrepreneurship



Source: author's own work.

The program contributes to Chalmers University's reputation as a leading academic and technological entrepreneurship institution in Europe, its impact going beyond company formation, fostering a broader entrepreneurial culture, and strengthening its educational and research mission.

Conclusion

It is widely known that commercialization processes at Polish universities are prolonged and hindered by numerous factors, including the absence of a top-down, prioritized national strategy for technology transfer, unclear legal regulations, and a science evaluation system that does generally not support commercialization efforts, resulting in a system that is not functioning effectively (Geodecki & Hausner, 2023). Both the number of companies created at universities[10] and other commercialization indicators remain significantly lower in Poland compared to countries leading in this area[11]. However, it is also important to acknowledge that commercialization processes in Poland were initiated relatively recently, and their institutionalization and outcomes are developing gradually, with the commercialization ecosystem still emerging. At the same time, the capital resources necessary for its growth are limited, originating mainly from public sources.

In response to whether the Swedish model can be adapted to the conditions of Polish technical universities (or other research institutions), the answer is affirmative, as none of the model's key components or implementation conditions discussed in this paper are inherently incompatible with the Polish context. First and foremost, the legal framework shared within the European Union ensures consistency in applied solutions, with the only notable difference lying in the legal ownership of intellectual property (IP), which in Sweden is governed by the so-called 'professor's privilege.' Nonetheless, alternative IP arrangements do not preclude the application of Swedish practices in a modified form.

Particular attention should also be paid to integrating commercialization with university teaching. The Swedish model provides students with a portfolio of knowledge, skills, competencies, and practical experience that enables them to act entrepreneurially in their future careers—whether as founders, contributors to entrepreneurship-supporting ecosystems, or leaders of innovation projects within corporations. Table 1 summarises the key differences and similarities affecting the adaptability of the Swedish student

[10] According to data obtained from Porozumienie Spółek Celowych, 241 spin-offs—defined as companies with equity participation from a university—were established in Poland between 2017 and 2023. Among the leading institutions are Nicolaus Copernicus University in Toruń (34 companies), Warsaw University of Technology (33 companies), the University of Warsaw (32 companies), and the AGH University of Science and Technology (29 companies). This does not mean that all these companies are operating successfully, and official data on their market and financial performances are not publicly available. Based on personal observations and informal expert interviews, it can be reasonably assumed that approximately 10–15% of these spin-offs are functioning well and actively developing.

[11] For comparison, the average number of spin-offs created annually by a single university is 1 in Poland, over 4 in the United Kingdom, and almost 6 in the United States (based on data from Porozumienie Spółek Celowych, Higher Education Statistics Agency, AUTM).

Table 1

Preliminary Analysis of the Adaptability of the Student Surrogate Entrepreneurship Model to Polish Conditions

Factor	Sweden (Chalmers)	Poland	Adaptability Potential
Legal framework (IP)	'Professor's privilege' – IP rights belong to the researcher.	No professor's privilege – the university typically owns IP.	**High** – viable legal solutions can be developed within the existing system.
Institutional readiness	The model has been developed for over 20 years; systemic integration of teaching and commercialization.	Commercialization processes are still immature; low commercialisation indicators.	**Moderate** – requires a shift in organizational approach.
Resource availability	Own seed fund, incubator, strong cooperation with business partners.	Mostly public capital, limited private resources, underdeveloped ecosystem.	**Moderate** – requires institutional and financial support.
Students (attitudes)	Carefully selected; deliberately choose a venture creation path as part of the programme.	No equivalent programme, but potentially strong interest in practical, hands-on education.	**High** – requires the creation of an educational track.
Researchers (attitudes)	Consciously refrain from becoming entrepreneurs; delegate their ideas to students.	Often reluctant to lose control despite declared openness to commercialization.	**Limited** – requires attitude changes and improved collaboration mechanisms.

Source: author's own work.

surrogate entrepreneurship model to the Polish condition.

Potential barriers to implementing this model in Poland arise from differences in IP regulations and the degree to which universities are ready to integrate teaching with commercialization systematically. A key condition also appears to be the presence of active stakeholders: researchers willing to collaborate, students prepared to take on the role of surrogate entrepreneurs, and competent and stable teams responsible for coordinating the processes discussed.

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Relation from the event

The 6th BPM Symposium, April 24–26 2025, Sopot (Poland)

The 6th BPM Symposium took place in Sopot from April 24 to 26, 2025, organized as part of the collaboration between the Daniel Fahrenheit Universities – Gdansk University of Technology and the University of Gdansk (Poland). This was the second meeting held under the patronage of FarU.

The BPM Symposium brought together over 50 participants representing more than 15 universities and 2 institutes of the Polish Academy of Sciences. The event was officially opened by: the Director of the Fahrenheit Universities, Prof. Adriana Zaleska-Medynska, Vice-Dean for Cooperation and Development at the Faculty of Management and Economics of Gdansk University of Technology, Prof. Michał Tomczak, and Vice-Dean for Internationalization and Development at the Faculty of Management of the University of Gdansk, Prof. Anna Dziadkiewicz.

The three-day event focused on issues related to business process management, with particular emphasis on modern ICT technologies. The symposium also served as a platform for the exchange of experiences between the academic community and management practitioners. For the first time, this year's edition included workshops dedicated to PhD students.

The next, 7th BPM Symposium will be held in 2026 at the Wroclaw University of Economics and Business (Poland). "E-mentor" is one of the event supporting journals.

Olena Bocharova

Case Studies as a Research Strategy in Comparative Education

Abstract

This article is an attempt at analysing one of the qualitative methods increasingly used in educational research, particularly in the context of dynamic social, cultural, and political changes. It focuses on the research question of how case studies are applied in comparative research, with particular emphasis on their strengths and limitations, the use of typological and processual approaches, and the role of the cultural and social context. The study adopts a qualitative approach, incorporating literature review, synthesis of data from various sources, and a three-dimensional (vertical, horizontal, transverse) comparison of selected cases. The findings demonstrate that this strategy is highly effective in studying educational processes in their natural settings and has strong potential to generate contextually grounded and in-depth conclusions. The summary underscores the importance of combining methodological approaches and accounting for contextual volatility to produce more relevant comparative interpretations.

Keywords: case study, comparative education, typological approach, processual approach, social and cultural context

Introduction

Case study research is one of the key strategies that has been employed for many years across a range of scientific disciplines. In the context of education systems, case studies are widely used to collect detailed information on various aspects of education (Cohen et al., 2000). Robert K. Yin (2009, p. 18) defines the case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." Yin argues that the potential for generalising findings from case studies is often limited and depends on how well the selected cases represent the sample studied. In turn, Robert E. Stake (1995, p. 127), describes the case study as "a research strategy which involves an in-depth study of specific programs, events or persons, taking into account their particularity and complexity in various contexts." For Jean Hartley (2004, p. 323), the key aim of the case study is "understanding processes as they occur in their specific environment, because no social phenomenon can be fully understood without its context." Henryk Mizerek (2017, p. 10) notes that "the selection of the cases is one of the most difficult stages in the process of designing the study," highlighting the ongoing debate over the precise definition of a case study.

In the context of comparative education,[1] the case study strategy allows in-depth analysis of educational policies and practices across countries. The World Bank's analyses of education reforms in developing countries illustrate how different contexts affect the implementation of educational policies (Steiner-Khamsi, 2006). As globalisation and political shifts exert more and more influence on education, case studies become ever more relevant, offering insights into diverse educational systems within their specific cultural and social settings (Little, 2000).

This article aims to present the significance of the case study in comparative education and its role in clarifying the differences and similarities between education systems. It addresses three research questions: What are the main advantages and limitations of

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[1] This paper uses the term "comparative education" in reference to the work of Mark Bray, Bob Adamson and Mark Mason titled *Education research: Approaches and methods* (2014). It constitutes an important source for understanding the methodology and approaches used in comparative research in education.

applying case studies in educational research? How do typological and processual approaches influence comparative analysis? How do social and cultural contexts shape the findings in comparative research?

This study employs a comprehensive scientific approach, integrating various analytical and synthetic methods to achieve a comprehensive view of the topic. The key stages of the process include: (1) literature review – aimed at collecting a broad spectrum of information from studies, articles, and reports to form a comprehensive picture of the current knowledge in the field; (2) data synthesis – involving the integration of information from various sources to gain a deeper understanding of the issues; and (3) formulation of conclusions – drawing key insights based on the integrated data and literature review.

Cases in Educational Research: The Typological Approach and the Processual Approach

The term "case" in the research context refers to contemporary phenomena analysed within a broader social and systemic framework. Definitions of this concept can be found in the works of Yin (2009) and Stake (1995), among others. Since the 1960s, two main streams have emerged in comparative education. One focuses on research concerning development and geographical regions; the other emphasises large-scale assessments of educational achievements, such as studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). Both recognise context and culture as important factors affecting the findings (Parreira do Amaral, 2022; Steiner-Khamsi, 2006).

Since the beginning of the 21st century, comparativists have increasingly more often adopted the case study strategy in their research (Bartlett & Vavrus, 2017; Little, 2000). The number of studies focused solely on single countries without meaningful comparisons is declining (Wiseman & Anderson, 2013). The acceptance and application of the case study strategy in research stems largely from globalisation and its impact on educational policy and practice. Moreover, debates in the social and human sciences on such issues as culture, context, space, place, and comparison have prompted a re-evaluation of case study methodologies in comparative and international education (Parreira do Amaral, 2022). In response, case study approaches in international research no longer view the social sphere as fixed and unchanging, but rather as dynamic. This perspective acknowledges that the social world is culturally constructed and inherently incomplete and fluid, in contrast to earlier views that treated social phenomena as fixed and natural.

Comparative case studies are defined as "the systematic comparison of two or more cases using the case study method" (Kaarbo & Beasley, 1999, p. 372). Researchers use case studies to investigate and compare units such as schools, education systems, or education policies to understand how context and conditions shape the phenomena studied, as well as to see what mechanisms underlie the differences and similarities observed. Such studies can reveal factors affecting the findings and practices across cases, thus allowing a better understanding and development of theories and practices in the field. Importantly, in comparative methodology, the case study is not confined to a single, isolated instance. Instead, it creates a broader analytical framework by comparing multiple cases, allowing for the identification of general patterns and principles that may apply in various situations. This makes it possible to formulate theories with broader relevance – particularly valuable in comparative education, where the study of diverse education systems under varying conditions and contexts is essential.

Comparative analysis distinguishes between two main approaches: typological and processual (Bartlett & Vavrus, 2016). Typological comparison involves directly comparing different cases to identify differences and similarities and to develop typologies or classifications. For example, a typological comparison would be the one examining differences between English-speaking and other countries in their approaches to education, as presented by John Furlong and Geoff Whitty (2017). In English-speaking countries, educational research often focuses on individual cases and specific local contexts. In turn, studies on education conducted elsewhere may adopt more standardised theoretical and methodological frameworks.

Processual comparison focuses on examining and following a given phenomenon, problem, or process across different contexts or levels (locally, regionally, nationally). In *Qualitative research design: An interactive approach*, Joseph A. Maxwell (2013) explores how various actors, circumstances, events, and related processes influence each other and how these interactions develop over time.

A case study makes it possible to understand both how organisational processes and human behaviours shape the context, and how the context, in turn, influences those processes and behaviours in an organisation (Kożuch & Marzec, 2014). Such analyses are vital for gaining full insight into the research context. Processual comparison requires methodological flexibility: researchers must adapt their methods as new insights emerge, which may lead to changes in the study's structure. An example of a processual analysis would be the study of the impact globalisation has on educational policy in three distinct countries – Denmark, Nepal, and China – as described by Stephen Carney (2009, p. 79). Despite significant differences, such as in economic development, political structures, and educational traditions, certain shared traits can be noticed. Global trends, such as an emphasis on 21st century skills, can be observed throughout the three countries. However, each country interprets and applies these trends in line with its own specific context. In this work, Carney (2009) introduces the term "policyscapes" to describe the complexity and

dynamics involved in developing and implementing education policies. This takes into account various factors such as local needs, international trends, domestic policy, national culture, and global influences which altogether make up the educational "policyscape" of each country analysed.

Typological comparisons identify patterns and categories in education systems, allowing a better understanding of differences and similarities. They are also instrumental in constructing typologies and classifications that are essential for formulating education policies and implementing reforms. In turn, the processual approach in comparative analysis enables a more in-depth understanding of education policy by uncovering the mechanisms and relationships that shape and influence policy implementation in varied contexts. Combining these approaches with the vertical, horizontal, and transverse dimensions of analysis provides a more comprehensive understanding of educational phenomena across contexts.

Frances Vavrus and Lesley Bartlett (2017) broaden the methodological perspective by introducing three analytical dimensions: horizontal (across research locations), vertical (across different levels, e.g. local, regional), and transverse (over time). Horizontal comparisons examine units at the same structural or hierarchical level; for example, it could be a comparison of education systems in countries with similar levels of economic development (Silova & Niyozov, 2020). Vertical comparisons explore the influence of different hierarchical levels on one another and track changes in the quality of education across those levels (Phillips & Schweisfurth, 2006). Transverse comparisons focus on analysing cases across different temporal or spatial contexts, such as in a study of education policies in various countries during the same year (Apple & Apple, 2004). Integrating typological and processual approaches with these three dimensions yields a holistic view of educational phenomena (Parreira do Amaral, 2022). This integration enables researchers to examine both the structural features of education systems and the evolving processes within different contexts and timeframes. A holistic approach that addresses multiple dimensions of research and remains sensitive to cultural and contextual factors is crucial for understanding the differences and similarities in education, as well as for identifying the key mechanisms and relationships that shape education policy.

Sensitivity to Culture and Context in Comparative Research in Education

Sensitivity to culture and context is key in comparative education research, as education does not operate in a vacuum but within specific social, cultural, and political frameworks. Contextual sensitivity requires researchers to consider local, social, institutional, and historical factors that shape educational practices. Robert LeVine's research (2002) demonstrates how cultural values influence the development of educational systems in various communities, while Robin Alexander (2000) underlines that culture is an integral element that shapes educational practices. Culture influences how education is conceptualised and implemented, and also affects social and educational structures. That is why in analysing education systems in different countries, it is crucial to consider the cultural context.

One example is the study by Jouni Välijärvi et al. (2002), which shows how historical and cultural factors have contributed to the success of the Finnish education system in the PISA 2000 study. Pirjo Linnakylä (2002) supports these conclusions, explaining that Finnish students' high performance is rooted in a longstanding cultural tradition that strongly values reading skills. This tradition was significantly shaped by the Reformation in Northern Europe (1517-1648), during which parents were required to read the Bible to their children. Since the 16th century, when Finland was part of Sweden, reading proficiency was necessary to receive sacraments and to enter into Christian marriage. Children's reading skills were publicly assessed during the annual *kinkerit*; the lack of reading skills meant public shame and denial of marriage. As a result, over the centuries, nearly every Finnish child was raised in a household where both parents were literate, which had a lasting impact on the development of reading proficiency across society. These examples illustrate how cultural and historical factors affect educational outcomes, as in the case of the Finnish education system, which reflects deeply rooted cultural traditions. To draw meaningful conclusions from cross-cultural comparisons, researchers must identify and account for all relevant contextual factors. Overgeneralisation can lead to oversimplified findings (Mason, 2014).

Integrating the horizontal, vertical, and transverse dimensions of the analysis while incorporating cultural and contextual considerations allows a more precise understanding of the differences and similarities between the education systems. In comparative studies, acknowledging both structural and processual aspects within their cultural and historical contexts enhances our understanding of the mechanisms shaping education policy and helps to identify the key factors influencing the functioning of education systems across different settings and periods.

Designing Comparative Research in Education

A case study may involve both flexible forms of inquiry and more structured approaches. Robert K. Yin (2009) identifies five main components of the design: the research questions, the propositions, the 'cases', the logic linking data to the propositions, and the criteria for interpreting the findings. In contrast, Robert E. Stake (1995) emphasises flexibility and the possibility of modifying the research plan as the study progresses, in line with the approach known as progressive focussing.

Unlike Yin (2009), Stake (1995) advocates for a flexible design that allows significant changes even after the research has begun. Although he does not specify when data collection and analysis should start, his recommendations on formulating research questions suggest that researchers should define two or three clear questions to "help structure observations, interviews, and document analysis" (1995, p. 20). The flexibility of Stake's approach derives from the concept of "progressive focussing," developed by M. Parlett and D. Hamilton (1976), who argue that "the course of the study cannot be completely planned in advance" (as cited in Stake, 1995, p. 22). This view stands in contrast to Yin's more rigid approach. Therefore, when designing comparative research using the case study strategy, it is important to consider several key factors.

The first key consideration is the number of cases. A single system of education may be enough, provided that the theory justifying the research is adequate to the purpose of the analysis. For instance, an in-depth examination of one school employing an innovative teaching method may provide valuable information on its specific properties if the researcher offers a strong rationale for case selection and mitigates subjective bias (Berg, 2004; Flyvbjerg, 2006). Conversely, analysing multiple cases enables broader testing of theory across different contexts, helping to generalise findings and identify universal patterns or limitations, for example, in evaluating the effectiveness of teaching methods across different schools.

Second, case selection must align with the research objectives. If the aim is to explore diversity in minority education or educational management, then incorporating examples from various education systems would be recommended. Such an approach can facilitate the development of typologies and foster a deeper understanding of the phenomena studied, allowing the researcher to capture the differences and similarities across cultural and educational contexts.

Third, case study analysis distinguishes between two main methods: case comparison and controlled comparison. Case comparison involves examining several cases to draw general conclusions. Controlled comparison starts with a single case, leading to the development of a theoretical model, which is then tested and refined using additional cases. Both models have their advantages and may be used depending on the research objectives. The case study strategy is thus suitable for both single-case analysis and multi-case comparative studies aimed at theory development.

Fourth, the level of detail in case descriptions is key in designing comparative research. Researchers may apply qualitative, quantitative and mixed methods. Regardless of the method chosen, it is important to include both detailed single-case analyses and broader comparisons across cases. Qualitative methods, in particular, allow for nuanced exploration of individual cases. In multi-case studies, the depth of analysis may range from meticulous analyses to more succinct summaries, which allows the researcher to better capture the differences and similarities in various contexts.

Ultimately, selecting an appropriate research design is critical to the success of comparative, case study-based research in education. The number and selection of cases, the analytical method, and the level of descriptive detail are all key factors that influence the quality and reliability of the findings. A thoughtful and deliberate approach to these issues can lead to a deeper understanding of the educational phenomena across various contexts and support the development of educational theory. Methodological literature also highlights the importance of such strategies as triangulation, which can help mitigate limitations and enhance the credibility of research findings (Yazan, 2015).

Summary. Final Remarks

The case study is a valuable research strategy in comparative education, allowing an incisive analysis of educational processes and phenomena within their real social and cultural contexts. The use of both typological and processual approaches allows a multifaceted examination of education systems, addressing not only their structural features but also the dynamic changes over time and across different settings. Integrating these perspectives enhances our understanding of the mechanisms that shape education policy, especially in the light of the complex interactions between local practices and global trends.

In addressing the research questions, it is important to emphasise that the case study method helps to identify the specific characteristics of local educational solutions and analyse their contextual conditions. Applying analysis across three dimensions (vertical, horizontal, and transverse) supports the multi-layered approach to educational challenges and enables cross-national comparisons.

At the same time, this strategy is not without limitations. Difficulties in generalising the findings, the diverse social and cultural contexts, the potential for interpretive subjectivity, and difficulties in accessing data across different countries all affect the quality and reliability of case study analyses. The complex nature of this research strategy demands careful design and critical reflection on the scope, objectives, and interpretation of the findings.

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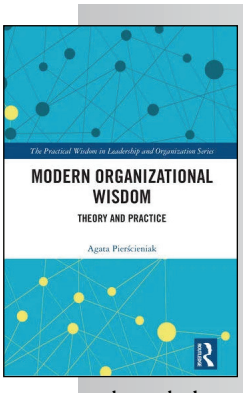

We recommend

Agata Pierścieniak, *Modern Organizational Wisdom. Theory and Practice*

Modern Organizational Wisdom: Theory and Practice presents a fresh perspective on knowledge management processes, exploring how employee expertise transforms into practical solutions for organizational challenges. This innovative concept, grounded in the scientific achievements of organizational learning and absorptive capacity, sheds new light on converting knowledge into action. The book introduces a procedure that links key knowledge management concepts, streamlining their understanding and simplifying their application. This approach makes complex phenomena more accessible and practical for professionals. In the theoretical section, the book outlines a straightforward model of Modern Organizational Wisdom (MOW), which consists of a knowledge-to-solution transformation process complemented by a set of organizational competencies essential to its success. Including these competencies as an integral component of MOW represents a groundbreaking approach to this subject. The practical section bridges theory with real-world applications, offering insights into how these phenomena manifest in business practice. Readers will discover the drivers that foster MOW and the obstacles that hinder its development. With its accessible language and innovative take on organizational wisdom, this book inspires researchers in knowledge and strategic management and is a valuable resource for practitioners. It helps leaders understand how their employees' knowledge can fuel business growth and success.
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Post-Pandemic Challenges in Maintaining Work-Life Balance Among School Teachers: Evidence from Kerala, India

Abstract

The work-life balance issues that Kerala, India's school teachers, confront in the wake of the pandemic's *new normal* are examined in this empirical, quantitative research. Using a descriptive-correlational approach, the study was grounded in the Role Strain Theory and directed by a positivist research paradigm. 116 respondents were chosen from a sample of instructors working in digital and hybrid learning contexts using a purposive selection approach. A systematic questionnaire with Likert-scale questions covering four important variables—co-worker contributions, flexible scheduling, digital work modes, and work-from-home practices—was used to gather data. Using SPSS, statistical analysis was carried out using multiple regression, ANOVA, Pearson correlation, and descriptive statistics. There is no strong statistical signal to support the idea that the variables significantly enhance or discourage work-life balance among female primary school teachers during the post-pandemic period; nonetheless, there were minor tendencies in the replies regarding work spillover and colleague support. According to these results, institutional and policy-level interventions are still crucial even if teachers are negotiating post-pandemic problems with differing degrees of success. In order to better assist educators in preserving a healthy work-life balance, the study recommends gender-sensitive regulations, context-specific tactics, and longitudinal research.

Keywords: new normal, work-life, digital work manner, COVID-19 pandemic, statistically analyze, modern classroom, teachers

Introduction

Substantial attention has been paid to the concept of balancing work and private life in the midst of the educational landscape's quick evolution, especially in the consideration of teachers adjusting to the *new normal*. The COVID-19 epidemic and the impact it had on education have forced teachers to deal with a variety of difficulties while attempting to strike the right balance between their personal and professional obligations. Concerns have been raised concerning the well-being and happiness of teachers due to the complexity of juggling expectations resulting from remote teaching, escalating workloads, and personal responsibilities.

The purpose of this study is to provide insight into teachers' ability to maintain a healthy work-life balance in the context of the *new normal*. This study is intended to provide insight into the effects of these problems on educators' general well-being and the caliber of their teaching by evaluating the particular difficulties they encounter in the contemporary educational environment. This study also intends to identify successful treatments and practices that can help teachers achieve and maintain a healthy work-life balance, which will eventually increase their retention and overall job satisfaction.

Objectives

1. To examine the challenges teachers face in maintaining a work-life balance in the post-pandemic environment.

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2. To comprehend how a lack of balance between work and life affects teachers' general well-being and sense of fulfillment in their positions.
3. To identify strategies and programs for maintaining a work-life balance in the current education system.
4. To establish whether there are significant differences in work-life balance scores when educators are categorized by gender.
5. To evaluate the effectiveness of institutional work-life policies in supporting female elementary teachers in Kerala during the post-pandemic educational shift.
6. To examine how work-life balance impacts teachers' job performance and classroom effectiveness in the post-pandemic period.

Review of Literature

According to Santiago (2023), teachers frequently struggle to maintain a healthy work-life balance, especially in the age of the *new normal*. The forced shift to remote teaching due to the COVID-19 pandemic has made it harder to keep personal and professional lives apart, increased workloads, and increased pressure to keep up with technological advancements. These difficulties have been shown in studies to negatively affect teachers' retention rates, work satisfaction, and general well-being.

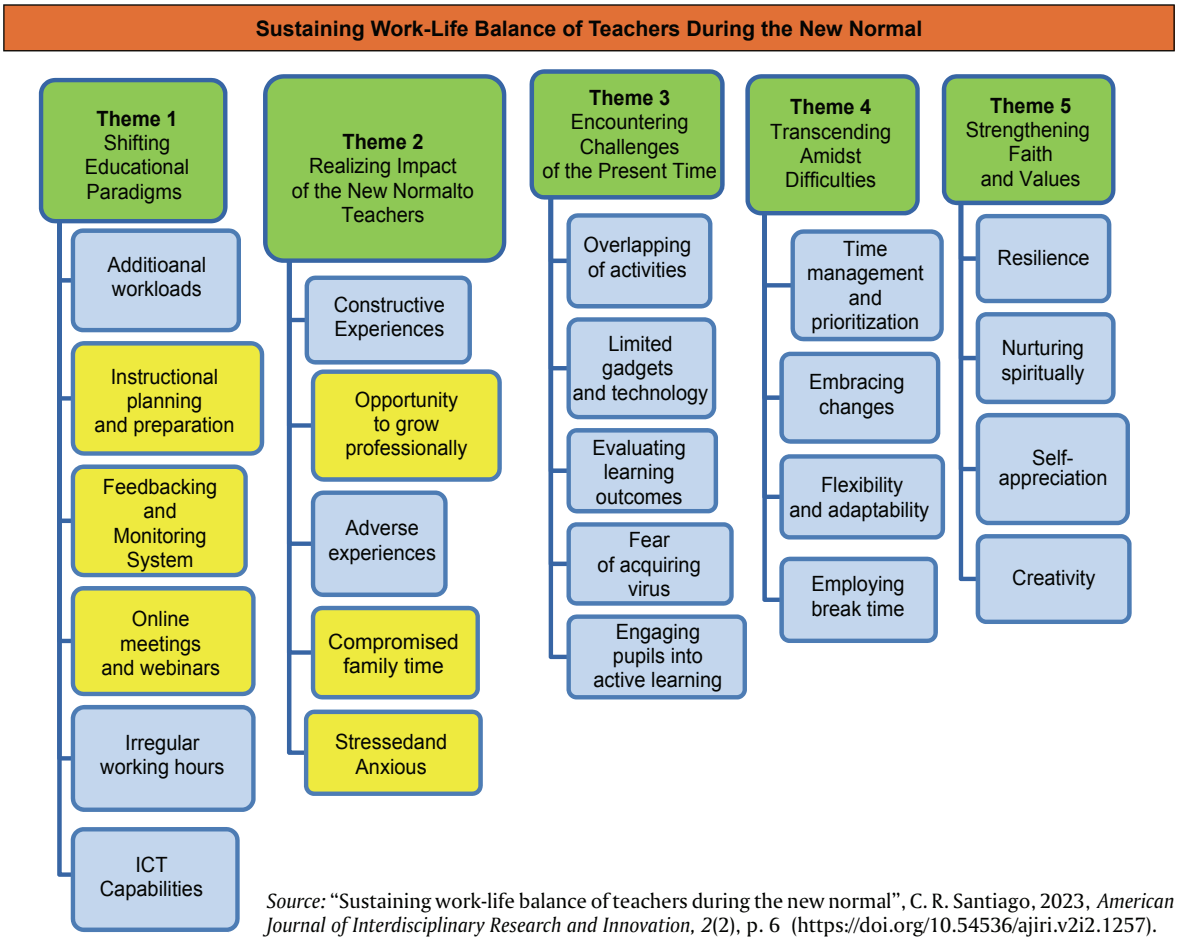
According to Adisa (2022), the balance between work and life among teachers is impacted by a number of factors. Significant workloads, a lack of autonomy, little administrative assistance, and insufficient work-life policies and practices are some of these. The influence of gender has also been investigated, and it was shown that work-life conflicts are exacerbated for female instructors, since they frequently have additional caregiving and household management obligations and demands.

According to San Jose et al. (2021), everyone was affected by the COVID-19 epidemic, but mothers raising children were affected in particular. This qualitative research primarily looked at how women are now instructors towards their children due to the new normal. Six women with elementary-aged children at both public and private schools were purposefully chosen. A validated interview questionnaire created by the researcher was used to collect the information.

The information was gathered online using e-mails and Facebook Messenger. Six topics emerged from

Figure 1

Model of Sustaining Work-life Balance of Teachers due to the New Normal



Source: "Sustaining work-life balance of teachers during the new normal", C. R. Santiago, 2023, *American Journal of Interdisciplinary Research and Innovation, 2*(2), p. 6 (https://doi.org/10.54536/ajiri.v2i2.1257).

the data analysis, including the challenges of being a mother and a teacher, the advantages of teaching one's own children, monitoring children's academic progress, children's perceptions of modular schooling, concerns for children's learning, and reflection on mothers' learning. Each topic was covered extensively (San Jose et al., 2021). The Department of Education can think about providing help through home-visit tutorials to address the condition of these women.

According to Kundu (2021), the COVID-19 pandemic was caused by the Coronavirus's lethality, and spread to every part of the world in an improbable amount of time. The World Health Organization (WHO) declared it as Serious Acute Respiratory Syndrome (SARS) pandemic. This fatal process was accelerated by human social connectivity. We were forced to endure a *once in a century* event because of the prolonged social isolation used as a preventative method to deal with the fatal viral activity and the numerous political, cultural, economic, and psychological effects of the COVID-19 epidemic (Kundu, 2021). We are all aware of the impact of the Coronavirus on people's physical health thanks to the measures taken by the government, the media, and numerous health-related organizations to raise awareness.

According to Leo et al. (2022), there is growing concern that women, particularly those who are pregnant, have been disproportionately affected by the COVID-19 epidemic. In comparison to their male colleagues, female educators, and those with childcare duties in particular, have also reported greater levels of stress and difficulties juggling work and personal obligations. It is not known precisely what causes these differences (Leo et al., 2022). While some have suggested that the gender-based division of household tasks is the key cause, other pandemic- and job-related stress may also play a role in female educators' elevated stress levels and difficulties with work and family obligations. This hybrid study method makes use of survey information from 752 educators across New York State to examine this issue. Results show that women experienced higher levels of anxiety and issues with work and family than men.

According to Rashid et al. (2021), a nation's progress is significantly influenced by its level of education. Having the power to effectively influence and prepare pupils, teachers are among the key players in the education industry. An atmosphere that is conducive to learning is essential for achieving this strategic objective in the education sector. The primary goal of the current study is to examine how stress, workload, and supervisory assistance affect teachers' job performance in Pakistani private educational institutions. To accomplish this goal, data have been gathered using a survey technique approach (Rashid et al., 2021). The faculty at private educational institutes in Islamabad received 300 surveys. *Regression, correlation, and mediation studies* were carried out to determine the empirical results.

According to Vyas (2022), teachers' capacity to balance their personal and professional life was greatly affected by supportive organizational policies and practices. For instance, the authors discovered that schools with accommodating leadership and flexible schedules had better levels of job satisfaction among their teachers and fewer instances of work-life conflict. The efficacy of such practices in the context of the *new normal*, however, has not been studied. Further research is required to comprehend how organizational assistance might be tailored to the difficulties experienced by instructors in remote or blended instructional contexts.

Anees et al. (2021), conducted a study on connection between teachers' job satisfaction and their ability to combine work and personal obligations. The results indicated a substantial positive relationship between work-life balance and general job satisfaction, highlighting the importance of aiding educators in establishing a favorable work-life balance. Work-life balance must take the health of teachers into account. Significant work-life conflict has been shown in several studies to have a detrimental effect on teachers' satisfaction with their jobs and overall well-being. However, studies have indicated that well-being-focused treatments, such as social support networks and mindfulness training, can improve teachers' ability to manage their professional and personal lives. The effectiveness of these treatments over the long term must be investigated, and innovative approaches need to be examined that might enhance teacher well-being in the face of the *new normal*. However, more study is required in these areas.

According to Tsen et al. (2021) certain research and technology may make it easier to implement flexible work schedules and reduce administrative hassles. The study produced contradictory results, with some research emphasizing how technology may improve flexibility, and other research finding that technology causes greater effort and blurs boundaries. Considering teachers' work-life balance, there are both advantages and disadvantages to integrating technology into the classroom. The study thoroughly reviewed the effect of the use of technology on teachers' ability to combine work and personal life. However, this study has revealed issues concerning the blending of both personal and professional life, since instructors find it challenging to take a break from job-related responsibilities. Understanding how the work-life balance is affected by technology in the modern workplace is essential to figure out how instructors might handle these difficulties.

Gender has been identified as a key element related to teachers work life balance, according to Abdulaziz et al. (2022) previous research has demonstrated that female instructors frequently have additional difficulties juggling their job and family obligations, such as an uneven division of childcare and housework. A teacher's sense of work-life balance may differ for male and female counterparts depending on society's standards and gender expectations. Addressing the distinctive requirements and experiences of educators across genders requires exploring the gendered components of a balance between work and life in the *new normal*. To comprehend a balance between work and life in the teaching field, numerous theoretical approaches have been employed. The role strain hypothesis contends

that stress and diminished well-being might result from different work and personal life demands (Demerouti & Bakker, 2022). According to the spillover idea, events and feelings from either a personal or professional realm may cross over and affect the overall balance. The maintenance of resources theory also highlights the significance of resource replenishment and allocation in preserving work-life balance.

Batongbakal (2024) aimed to investigate the impact of teachers' stressors and work-life quality on their commitment and performance in the new normal. 332 teachers were surveyed using a descriptive-correlational method. Data were collected using standardized instruments, and documentary analysis was used for teaching performance. Results showed that teachers experienced significant stressors due to role overload, job design, role conflict, and relationships with school administrators. They also valued a high quality of work life, organizational culture, and various aspects such as training, compensation, facilities, job satisfaction, security, autonomy, and resource adequacy. Teachers' commitment was primarily affective, continuance, and normative. Teachers had a satisfactory rating on their IPCRF, with job stressors significantly affecting both affective and continuance commitment. Quality of work life also significantly affected affective commitment, with a t-value of 8.581817 and a p-value of 0.000.

Maria N. Cusipag et al. (2024) examines the effects of employer support, workspace, and attitudes on work-life balance and job satisfaction in online teaching in the Philippines. A total of 256 responses were analyzed using SmartPLS. The results showed that workspace positively influences work-life balance but not students' attitudes. Job satisfaction may be affected by workspace but not full employer support. Teaching online is positively affected by workspace and employer support but not students' attitudes. Future research should consider varied statistical tools, wider school sampling, and replication in different regions.

A study by Manalo and Velasco (2024) examines the relationship between work-related variables and work-life balance among 120 elementary school teachers in the Division of Lipa City. The results show that factors such as working hours, vacation and leave, quality time, and overall health significantly impact teachers' work-life balance. The study recommends prioritizing time management and physical exercise for teachers to avoid stress, anxiety, and poor mental health, as extra work and extended hours are inevitable in the teaching field.

Materials and Methodology

Research Design

This study is an empirical, quantitative analysis designed to explore the correlation between remote work practices, flexible schedules, digital work modalities, and colleague contributions among female primary school educators in Kerala, India, in the post-pandemic *new normal*. The study used a structured questionnaire and applied statistical methods like correlation, ANOVA, descriptive statistics, and multiple regression analysis to evaluate the relationships and impacts among the chosen variables.

Participants

The target population included female teachers employed in both public and private elementary schools in Kerala. A total of 150 questionnaires were distributed via online platforms such as e-mail and WhatsApp, with 116 fully completed responses returned, resulting in a 77.3% response rate. Participants were selected using a purposive sampling technique, ensuring that those included were actively engaged in digital or hybrid teaching modes and had relevant experience balancing professional and personal responsibilities during COVID-19.

Data Collection

A questionnaire with a predefined format was used to gather data that measured four primary aspects:

- Work-from-home behaviors
- Flexible work schedules
- Virtual work modes
- Co-worker input.

Respondents were asked to state how much they agreed with a series of statements using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Experts in this subject area validated the questionnaire for content relevance and clarity. All research was carried out according to ethical standards, with electronic consent and anonymous and confidential data storage.

Data Analysis

Data analysis was conducted using SPSS, focusing on the following statistical techniques:

1. Correlation analysis
   The study used Pearson correlation coefficient to analyze the relationships between work-from-home practices, flexible timings, digital work modes, and co-worker contributions.
2. ANOVA
   The study aimed to compare means and assess significant differences between groups using one-way ANOVA for co-worker contributions, digital work modes, flexible timings, and work-from-home practices.
3. Descriptive statistics
   The objective was to provide a comprehensive summary of the dataset's main features using descriptive statistics such as mean, standard deviation, percentiles, range, minimum, maximum, skewness, and kurtosis.
4. Regression analysis
   The study aimed to analyze the correlation between co-worker contributions, digital work modes, flexible timings, and work-from-home practices using multiple regression analysis, aiming to determine the extent to which predictors explain the variance in the dependent variable.

Limitations

This study, however, has certain drawbacks. Firstly, relying heavily on data collected through survey questionnaires in which respondents self-report might result in bias and limits due to participant responses. Additionally, the use of a particular online survey platform might result in selection bias, because not all instructors may have the same access to or inclination to participate. The study's particular setting and sample population may restrict how broadly the results may be applied.

Results and Discussion

Correlations

The Pearson correlation coefficient of the variable *I sometimes bring work home, but it's just a few things I may not have finished up* was 1. This was expected, as it is perfectly correlated with itself. Meanwhile, there was no strong correlation between this variable and the belief that *flexible timings of digital and remote work mode are beneficial for a positive work life*, as reflected by a very low correlation value of 0.065 and a p-value of 0.628, which implies no statistical significance.

This result partially contradicts previous studies. For example, Vyas (2022) highlighted that flexible working hours had a positive impact on work-life balance, especially when complemented with organizational policies. In the same way, Awan and Naz (2022) noted that home-based university teachers were more satisfied if flexible timing was permitted. Yet, in this study, such flexibility had little effect on whether teachers took work home, perhaps because of variation in job assignments, school-level tasks, or institutional assistance in the Kerala context. The absence of significance in this research indicates that although flexibility is valued in theory, it does not necessarily decrease after-hours workload or improve actual work-life balance without systemic reform. This emphasizes the need toexamine further how such policies enacted and lived by teachers in practice.

While the first variable hints at the idea that working digitally is bad for one's physical and mental well-being, the discussion does not offer any concrete information or proof to back up or elaborate on this claim. The possible correlation involving digital occupation and mental/physical well-being requires careful investigation, taking into account variables including workload, ergonomics, work-life balance, and individual experiences. Co-workers supposedly have a good effect on the workplace, according to the second variable (Alfatihahet al., 2021). This shows that having co-workers around and interacting with

Table 1

Correlation Between Work From Time and Flexible Time

		I sometimes bring work home, but it's just a few things I may not have finished up	Flexible timings of digital and remote work mode are beneficial for a positive work life (3 questions related to online education)
I sometimes bring work home, but it's just a few things I may not have finished up	Pearson Correlation Sig. (2-tailed) *N*	1 64	0.065 0.628 58
Flexible timings of digital and remote work mode are beneficial for a positive work life (3 questions related to online education)	Pearson Correlation Sig. (2-tailed) *N*	0.065 0.628 58	1 58

Source: authors' own work based on SPSS.

Table 2

Correlation Between Digital work and Co-worker Contribute Towards my Work Environment

		Digital work is detrimental to mental and physical health	Co-workers positively contribute to my work environment (2 questions related to work environment satisfaction)
Digital work mode is detrimental to mental and physical health	Pearson correlation Sig. (2-tailed) *N*	1 58	–0.044 0.744 58
Co-workers positively Contribute to my work environment (2 questions Related to work Environment satisfaction)	Pearson correlation Sig. (2-tailed) *N*	–0.044 0.744 58	1 64

Source: authors' own work based on SPSS.

them positively affects how much work is done, how well others work together, how much support there is, and how enjoyable work is. It might be difficult to completely comprehend the exact elements or behaviors of co-workers that assist in this productive work environment without further context or information.

ANOVA

Co-workers positively contribute to my work environment (two questions related to work environment satisfaction)

The outcomes of the ANOVA reveal a *Between Groups* combined value of squares of 6.824 and a *Within Groups* average of squares of 101.607 for the sample size 3.0 and 2.275 are the mean square and degrees of freedom (*df*) for the between-groups data, respectively. The f-value is 1.209, and the p-value (Sig.) is 0.315.

Means Plots

ANOVA

Flexible timings of digital and remote work mode are beneficial for a positive work life (three Questions related to online education)

According to the ANOVA findings, the squared sums *Between Groups* and *Within Groups* are 9.487 and 118.030 respectively. The *between groups* correlation has three degrees of freedom (*df*) and a mean square of 3.162. The f-value is 1.447, and the p-value (Sig.) is 0.239.

Table 3

One-Way Anova for Co-Worker Contribution and Digital Work

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	6.824	3	2.275	1.209	0.315
Within Groups	101.607	54	1.882		
Total	108.431	57			

Source: authors' own work based on SPSS.

Table 4

Co-workers Positively Contribute to my Work Environment (Two Questions Related to Work Environment Satisfaction)

Robust Tests of Equality of Means[a]

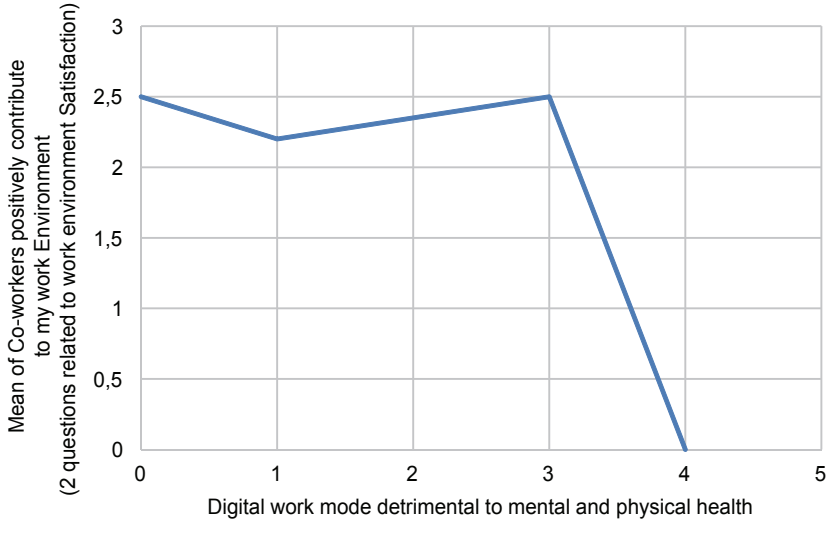
	Statistic[b]	*df1*	*df2*	Sig.
Welch	1.189		48.6	0.319
Brown-Forsythe	1.174	3	50.2	0.325

Note. a. Robust tests of equality of means cannot be performed if co-workers positively contribute to my work environment (two questions related to work environment satisfaction) because at least one group has the sum of case weights less than or equal to 1. b. Asymptotically F distributed.

Source: authors' own work based on SPSS.

Figure 2

Mean Plot for Co-worker Contribution and Digital Work



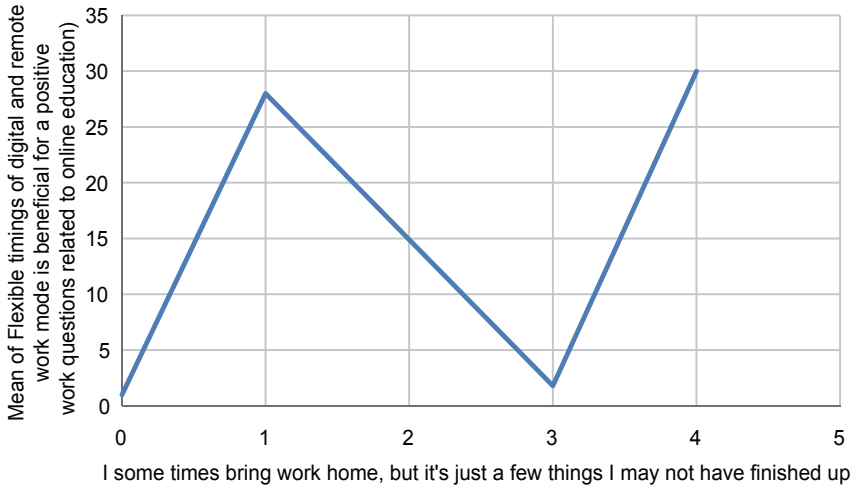
Source: authors' own work based on SPSS.

Table 5
One-Way Anova for Flexible Timings and Work from Home

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	9.487	3	3.162	1.447	0.239
Within Groups	118.03	54	2.186		
Total	127.517	57			

Source: authors' own work based on SPSS.

Figure 3
Mean Plot for Flexible Timings and Work from Home



Source: authors' own work based on SPSS.

The p-values (0.315 and 0.239) are higher than 0.05 for both variables, and the F-values are lower than 1.447 for both. According to the questions on happiness in the work environment and the flexibility of digital and remote employment modes, there may not be a statistically significant distinction between the groups (Awan & Naz, 2022). In other words, the data we currently have failed to promote the existence of significant differences in these factors between groups.

Descriptive Statistics Analysis

Statistics

The descriptive analysis showed that overall the participants did not strongly agree with the advantages of flexible work arrangements, with a mean score of 1.79 for the statement *Flexible timings of digital and remote work mode are beneficial for a positive work life*, which is different from previous studies by Vyas (2022) and Awan and Naz (2022), which highlighted the positive effect of flexibility on teachers' work-life satisfaction. Likewise, the low mean rating of 1.29 for *Digital work mode is harmful to physical and mental well-being* shows that the majority of respondents did not view digital work as harmful, which contradicts evidence provided by Tsen et al. (2021) and Leo et al. (2022), who described huge mental and physical burdens experienced by teachers during the pandemic. The mean of 2.30 for *I sometimes bring work home* indicates a moderate amount of work spillover into off-work time, consistent with Adisa (2022), but not high levels of overload. Finally, the mean of 2.48 for *Co-workers positively contribute to my work environment* indicates a moderate sense of peer support, partly consistent with Alfatihah et al. (2021), who concluded that co-worker interactions have a positive effect on job satisfaction. Overall, whereas the present study's findings support some of the previous studies, there are main differences indicating contextual factors—institutional support, work culture, and regional adaptability—which can influence teachers' experiences amid the post-pandemic transition towards the new normal.

Regression

The regression model's constant term is 2.520. The coefficient of the variable *Digital work mode is detrimental to mental and physical health*, which is –0.042, shows that the dependent variable and the independent variable have a negative connection. Given that the standardized coefficient (Beta) is –0.044, the impact could not be very significant. The t-value is –0.328, which is statistically insignificant ($p > 0.05$). Collinearity issues are avoided by using the adaptability (1.000) and VIF (1.000) values.

Table 6

Descriptive Analysis of Selected Variables

		Flexible timings of digital and remote work mode is beneficial for a positive work life (3 questions related to online education)	Digital work mode is detrimental to mental and physical health.	I sometimes bring work home, but it's just a few things I may not have finished up	Co-workers positively contribute to my work environment (2 questions related to work environment satisfaction)
N	Valid	58	58	64	64
	Missing	6	6	0	0
Mean		1.79	1.29	2.30	2.48
Std. Error of Mean		0.196	0.187	0.151	0.171
Median		3.00	1.00	3.00	3.00
Mode		3	0	3	3
Std. Deviation		1.496	1.427	1.204	1.368
Variance		2.237	2.035	1.450	1.873
Skewness		–0.089	0.397	–1.108	–1.059
Std. Error of Skewness		314	0.314	0.299	0.299
Kurtosis		–1.717	–1.705	–0.489	–0.358
Std. Error of Kurtosis		618	0.618	0.590	0.590
Range		4	4	4	4
Minimum		0	0	0	0
Maximum		4	4	4	4
Sum		104	75	147	159
Percentiles	25	0.00	0.00	1.00	3.00
	50	3.00	1.00	3.00	3.00
	75	3.00	3.00	3.00	3.00

Source: authors' own work based on SPSS.

Table 7

Regression Analysis between Co-Worker Contribution and Digital Work Mode

Model Summary[a]

Model	*R*	*R* Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	*F Change*	*df1*	*df2*	Sig. F Change	
1	0.044[b]	0.002	–0.016	1.390	0.002	0.108	1	56	0.744	1.882

Note. a. Dependent Variable: Co-workers positively contribute to my work environment (two questions related to work environment satisfaction).
b. Predictors: (Constant), digital work mode is detrimental to mental and physical health.

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1. (Constant) Digital work modeis detrimental to mental and physical health.	2.520 –0.042	0.247 0.129	–0.044	10.190 –0.328	0.000 0.744	1.000	1.000

Note. a. Dependent Variable: Co-workers positively contribute to my work environment (two questions related to work environment satisfaction).

Source: authors' own work based on SPSS.

Table 8

Regression Analysis between Flexible Timings and Work From Home

Model	*R*	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	*df1*	*df2*	Sig. F Change	
1	0.065[a]	0.004	–0.014	1.19						
					0.004	0.238	1	56	0.628	2650

Note. a. Predictors: (Constant), flexible timings of digital and remote work mode are beneficial for a positive work life (three questions related to online education).

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1. (Constant)	2.287	0.245		9.327	0.000		
Flexible timings of digital and remote work mode are beneficial for a positive work life (3 questions related to online education)	0.051	0.105	0.065	0.488	0.628	1.000	1.000

Note. a. Dependent Variable: I sometimes bring work home, but it's just a few things I may not have finished up.

Source: authors' own work based on SPSS.

Model Summary

The dependent variable's variance is only 0.4% according to the R-square value of 0.004, which is low. The variable that predicts the *Flexible timings of digital and remote work mode is beneficial for a positive worklife*" has coefficients that are not statistically significant ($p > 0.05$). When the tolerance (1.000) and VIF (1.000) values are used, collinearity problems are not present.

Conclusion and Future Scope

Conclusion

The research indicates that flexible working times, virtual working modes, and co-worker support are seen with moderate positivity, yet there is no strong statistical signal to support the idea that the variables significantly enhance or discourage work-life balance among female primary school teachers during the post-pandemic period. The mid-range responses and non-significant correlations indicate that teachers are coping with the demands of personal and professional life with differential levels of success, as opposed to all struggling or succeeding. These ambiguous findings speak to the complexity and specificity of work-life experiences in the new normal. Hence, instead of concluding that teachers are unable to achieve balance, the study highlights the imperative of context-specific institutional support mechanisms and policy interventions that can enhance the capacity of teachers to balance their roles in a sustainable manner. Future research needs to target longitudinal studies, measure the influence of work-life dynamics on teaching performance and student outcomes, and investigate context-specific measures to facilitate sustainable work-life balance among teachers.

Future Scope

Conducting longitudinal studies, examining the impact on student results, and creating specific approaches based on research findings are all future areas of focus for the assignment on maintaining work-life balance for teachers throughout the new normal.

Recommendations

- The unique difficulties instructors experience in the New Normal require further study.
- Work-life rules and procedures need to be put in place to address excessive workloads, a lack of independence, and inadequate support.
- More institutional assistance needs to be provided to women teachers, understanding that gender-related assumptions and family responsibilities can aggravate the challenges to balancing work and life.
- Theoretical stances such as the role strain assumption and the spillover concept need to be investigated to comprehend the complexities of work-life balance.
- The efficacy of the current interventions and strategies needs to be assessed to assist teachers in preserving a good work-life balance.

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Communication of Gifted Students with Teachers at the Stage of Initial Education During Crisis Remote Education from the Perspective of Parents' Survey Results

Abstract

The introduction of remote education during social isolation caused by the Coronavirus pandemic changed the way communication takes place during the learning process. This article describes the results of a survey conducted among parents of gifted pupils aged 7–11. Parents ($N = 712$) completed an electronic questionnaire containing open and closed questions. The research aimed to analyze the process of communication between a gifted student and a teacher in distance education during the pandemic. The study examined the possibilities, conditions, and forms of communication as well as how parents perceive and assess the communication process. The results show that only 26.4% of students have comfortable conditions for communicating in distance learning. The activity of students, contact with teachers and peer relations have deteriorated significantly in relation to traditional education. There was no indication of any systemic support for gifted students, nor any attempts to improve the process of communication between students and teachers.

Keywords: remote education, distance learning, gifted students, mediated communication, COVID-19

> The medium (…) is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and reevaluate practically every thought, every action, and every institution formerly taken for granted. Everything is changing – you, your family, your neighborhood, your education, your job, your government, your relation to "the others." And they are changing dramatically. (McLuhan & Fiore, 2019, pp. 8–9)

Introduction

In remote education, also known as distance education and e-learning, a student works without physical, direct contact with the teacher and classmates, and knowledge is transferred using electronic media (Burns, 2011). Interpersonal communication is replaced by mediated communication[1]. The prerequisites for success of this form of

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[1] One of the most popular ways in which communication is divided is the one according to the type of contact of the broadcaster and recipient of messages, where we can distinguish between interpersonal, intrapersonal, indirect (mediated) and social communication. The first is a kind of contact between two or more people, and "it happens when each of the people involved speaks and listens in a way that maximizes what is personal" (Stewart, 2012, p. 55). The second is conversing with yourself. Indirect communication takes place using media, tools for transmitting information that are a means of communication (Goban-Klas, 2005), e.g., telephones, messengers, e-mails, letters, press, radio, television, books, advertising banners, etc. The last of the types mentioned takes place between groups of people, societies, nations, etc. The second known division relates to the elements of verbal and non-verbal communication, which are interdependent, interact with each other, and which the interlocutors experience together (Stewart, 2012). Verbal communication refers to spoken (oral verbal) and written (non-verbal) language (Stewart, 2012), including mediated and social communication. The non-verbal elements include tone of voice, the pace of speech, volume, gestures, facial expressions, clothing, and objects that surround us. In mediated communication, we experience a strong depletion of non-verbal elements.

teaching include the availability of technology, didactic resources and the IT competences of participants, while this mainly depends on the needs and attitudes of learners (Łangowska-Marcinowska, 2020). The main reasons for using this form of education are the inability to gather students in a specific time and place; a low level of access to traditional education; teaching and learning outcomes that can be achieved through distance education comparable to on-site education; access to content, teachers, and experiences that are not available in traditional education; access to learning regardless of time and place (Burns, 2011). A factor that has not been considered to date and which has become one of the main reasons for switching to distance learning was social isolation related to the COVID-19 pandemic (Romaniuk & Łukasiewicz-Wieleba, 2020c) and the possibility of maintaining the continuity of education.

The rapid transition to distance learning and the lack of adequate preparation for this form of education, both for teachers and students (Ptaszek et al., 2020), in the initial phase, often meant that they experienced yesterday's tools – with yesterday's concepts (McLuhan, 2005). Young people came to be referred to as COVID's lost generation, the COVID-19 generation, lockdown generation or Corona generation (Barford et al., 2021; Daruwala, 2020; International Labour Organization, 2020; Kutwa, 2021) thus characterizing the situation they faced, e.g. limited contacts and direct communication, thus weakening social relations, the need for distance learning, destabilization, an increased sense of loneliness and a decline in mental well-being (Lee et al., 2020).

Gifted Students During a Pandemic

The pandemic seriously affected the process of identifying and educating gifted students[2]. Gifted students are students with special educational needs (Zaremba, 2014), but sometimes the care with which they are provided is limited due to the erroneous belief that if they are gifted, they will cope on their own. Impoverishing the communication process and reducing it to mediated communication drastically limits the ability to see, diagnose and develop students' abilities. The changes implemented to maintain the continuity and quality of education had an impact on various aspects of education processes, e.g., technological possibilities, motivation and teaching methods, relationships and communication. The persons affected were teachers, students and parents. New methods specific to the remote learning and teaching process were developed (Erdem, 2021).

School closure and isolation caused a greater psychological burden among parents, including parents of gifted students who admitted to having more frequent family conflicts. Self-regulation of students' ability to learn was disrupted, and the limitation of direct contact and free movement caused negative effects such as sleep disorders, depression, a feeling of isolation, frustration, and loss of motivation. Gifted students had a negative attitude towards remote learning, which they considered ineffective (Abud, 2021). There was no enrichment of the teaching process and challenges, and parents pointed to the decline in the availability of support and services for gifted students.

However, some possibilities of meeting academic and socio-emotional needs using IT tools and mediated communication were noticed (Romaniuk & Łukasiewicz-Wieleba, 2021; Wolfgang & Snyderman, 2021), reported both by students (Romaniuk & Łukasiewicz-Wieleba, 2020b) and lecturers (Romaniuk & Łukasiewicz-Wieleba, 2020a). Problems with maintaining the attention of gifted students during distance education were observed (Trzcińska-Król, 2020). Gifted students paid attention to communication, technical and time management problems. In the case of gifted students who implemented an individual curriculum and teachers who supervised it, a consensus was noticed about the goals and expectations set, and an evaluation of the teaching process demonstrated that these goals and expectations were realized (Ceylan & Umdu Topsakal, 2021).

Effective attempts were made to reduce the negative impact of the pandemic on the mental health of

[2] Many European countries use different terms and definitions to refer to gifted children and adolescents (European Commission…, 2006). In Poland, there is no legal definition of a gifted student, but legal acts use the term *particularly gifted student* (Giza, 2011; Łukasiewicz-Wieleba, 2018), which is included in the group of people with special educational needs (Rozporządzenie…, 2017).
In theoretical concepts, a gifted student is defined differently depending on the measurement of achievements and personality. In psychological terms, a gifted student is a person with outstanding intellectual abilities. Additionally, attention is paid to the motivation of these students and their temperament. In pedagogical terms, a gifted student has school achievements, exceptionally good grades at school and high-level achievements in competitions. From the pedagogical and psychological perspective, the characteristics of a gifted student are based on their achievements and properties of motivation and social functioning (Giza, 2011). Researchers specialized in gifted individuals have identified four groups of features that characterize gifted students. Among them are general cognitive abilities, special talents in a specific field, creative activity, and leadership skills (Nęcka, 2005).
In pedagogical literature, one of the classic definitions is the one presented by Tadeusz Lewowicki (Lewowicki, 1986), in which a gifted student is characterized as having "a high level of general abilities, intelligence; high level of special abilities, talents; high-level achievements or opportunities for such achievements in science or other fields of socially valuable activity; original and creative achievements or the possibility of such achievements" (Łukasiewicz-Wieleba, 2018).

students with online interventions in Philosophy for Children (P4C), which reduced mental health problems, and the introduction of mindfulness classes (Mindfulness-Based Interventions – MBIs), which helped meet basic mental needs (Malboeuf-Hurtubise et al., 2021). Programs to increase mental resilience in children capable of live online conduct were adapted to address the significant increase in exposure to mental health problems caused by the pandemic (Parrot et al., 2021). The researchers sought to determine which cognitive and emotional needs of gifted students can be identified and satisfied remotely, pointing to the significant role of parents, teachers, and schools' cooperation in this area (AlAli, 2021).

While information and communication technologies proved to be a useful method of working and communicating with gifted students, to be effective they should be used in conjunction with other forms of intervention and educational programs carried out directly (Alqahtani & Alqahtani, 2021). Attempts to measure the effects of the Coronavirus pandemic on gifted students revealed a slight impact on the quality of life in the dimensions measured using the Gifted Students' Quality of Life Scale (QOL-GSS), but this impact depended on the gender of the respondents, the education of the immediate family and standard of living (Erçetin et al., 2021). In some countries, the special educational needs of students were not met, parents felt helpless, and research showed that schools did not have the facilities to operate remote education (Kaur, 2020; Trzcińska-Król, 2020). In others, attempts were made to enrich the curricula and diversify the methods of transferring knowledge, and adopt diverse methods of working with gifted students (Cildir, 2020). Extracurricular education was found to be important during the pandemic, especially in the case of computer science (Panskyi et al., 2021). The main causes of concern for parents were identified, and these occurred regardless of the place in the world. These concerns were disappointment with brief human interaction during the courses, fear about whether students understood the subject, increased burden of annoying adult responsibilities, concern for children's eyesight, doubts about the sufficient detail of teachers' explanations, and concerns about a decline in students' interest and attention in online courses (Cui et al., 2021).

Methodological Arrangements

The research aimed to analyze the process of communication between a gifted[3] student and a teacher in distance education during the pandemic, as seen by parents. The study examined the possibilities, conditions, and forms of communication, as well as how parents perceive and assess the communication process between a gifted student and a teacher.

The reason for addressing this issue is the need to analyze the impact of the pandemic on the process of communication between students and teachers, as well as the desire to encapsulate and understand the changes that take place within it. The adopted perspective of parents of gifted students with special educational needs is rarely considered. Additionally, these children experienced the necessity of remote learning at the beginning of their educational path.

The study used the diagnostic survey method. An electronic questionnaire for students' parents was constructed using the online form available through Google Forms. The survey was addressed to parents of students aged 7–11 and consisted of 33 questions. The questions included 11 regarding housing conditions, four on evaluation of the student's work (including one question about 15 elements of education), seven regarding how a child stood out from peers in academic, social, sports and artistic areas, 11 regarding the child's abilities, and a question about personal details. The survey consisted of closed questions (single and multiple choice) and open questions allowing free expression and in which reasons could be given for the choices made. The collected information was statistically analyzed using the IBM SPSS 27 program.

The research was conducted at the turn of June and July 2021. The questionnaire was sent to primary schools in Poland via e-mail. Parents with more than one child filled in multiple questionnaires accordingly.

Characteristics of the Studied Sample

The participating parents with more than one child were able to fill in multiple questionnaires accordingly. As a result, data on 848 children was obtained. The criterion for recognizing a child as a gifted student was parental nomination. Parents who characterized their child as a gifted student were asked to indicate the areas in which the child's abilities manifested themselves (in terms of learning, sports, artistic fields, and social areas), possible achievements and successes, and participation in activities that developed their abilities, passions and interests.

The study selected a group of 712 parents with children aged 7–11 (table 1), whose children showed abilities or talent. The areas in which children had special abilities declared by the parents were learning (296 responses, 41.6%), sport (270 responses, 39.9%), social competences (175 responses, 24.6%), arts (355 responses, 49.9%) and other fields (72 indications, 10.1%). The abilities were confirmed by the achievements of children in contests (301 responses, 42.3%), competitions (93 responses, 13.1%), tournaments (80 responses, 11.2%), school subject competitions (12 responses, 1.7%) and other similar events (22 responses,

[3] The definition of a gifted student was adopted as formulated by Lewowicki (1986).

Table 1
Age of Respondents' Child

Child's age	*N*	Percentage
7	3	0.4
8	234	32.9
9	238	33.4
10	229	32.2
11	8	1.1
Total	712	100.0

Source: authors' own work.

Table 2
The Person Completing the Survey

	N	Percentage
Mother	649	91.2
Father	55	7.7
Legal guardian	5	0.7
Other person	3	0.4
Total	712	100.0

Source: authors' own work.

3.1%). A lack of documented achievements of the child was declared by 45.1% of parents[4] (321 responses).

Caregivers (mainly mothers 91.2% – table 2) commented on 345 girls (48.5%) and 367 boys (51.5%).

The largest percentage of students were children living in rural areas (261 responses, 36.7%), and a smaller percentage were students living in large cities (200 responses, 28.1%). One in five students lived in a medium-sized city (18.7%, 133 responses). The smallest group was students from small towns (16.6%, 118 responses).

The tutors assessed the material conditions at an average level of 3.89 ($Min = 1$, $Max = 5$, $Me = 4$, $Mo = 4$, $Ske = –0.219$, $K = –0.281$).

The Findings

The starting point for considering communication issues is to identify the environmental conditions. In the sample, 65% (463) of students had their own room, 31.9% (227) shared a room with their siblings, and 2.7% (19) shared their room with the whole family. Most of the respondents (454 people, 63.8%) declared that their children had their own room where they could study. Another significant group (156 people, 21.9%) was people whose children shared a room with their siblings, but still had their own place to study there. Worse conditions, such as the child's own place of study located in the family room (68 people, 9.6%) or the need for the child to share a place of study with siblings (22 people, 3.1%) were declared by one in eight respondents.

However, only 61.5% of students (438 responses) who had their own room during online lessons studied in that room. Other children had their place of study in the family room (17 people), in a room shared with siblings (3 people), shared work with other siblings (one person) or did not have their own place to study in the family home. This distribution of the sample may result from the specificity of the work of children at this school age, and the need to supervise, check, care for or explain to the child any ambiguities caused, for example, by communication barriers accompanying online study.

The technical background of students, the electronic equipment and the type and quality of the Internet connection may also affect the communication process during distance learning. Most of the respondents (459 people, 64.5%) declared that their children had their own computer (desktop or portable). One in five children (151 people, 21.2%) had to share equipment with other family members. A similar number of students (137 people, 19.2%) used mobile devices to communicate with the teacher and peers. A small number of parents were forced to borrow computer equipment for their children (27 people, 3.8%), but there were a few people who did not equip their children with remote learning equipment (4 people, 0.6%).

Most of the children used a permanent connection to the Internet, i.e., via a cable modem or optical fiber (384 people, 53.9%), or a wireless connection, i.e., via a modem to a SIM card (317 people, 44.5%). One in twelve children (57 people, 8%) had to use the Internet via a smartphone. One person declared a complete lack of internet access at home.

The continuity of mediated communication via the Internet can be disrupted by various technical or organizational problems. The respondents mentioned many difficulties that their children encountered, such as transmission problems during communication (406 people, 57%), problems with the internet connection (323 people, 45.4%), problems with hardware and equipment (162 people, 22.8%) or software problems (64 people, 9%). One in five respondents (159 people, 22.3%) stated that their child did not experience any technical problems. One in ten people (68 people, 9.6%) found it problematic that there are situations when all household members want to use the main computer at the same time. It can also be problematic for a child to communicate in a room where another person, siblings, or parents (182 people, 25.6%) are present and communicating. For some of the respondents (122 people, 17.1%) the lack of computer

[4] When writing about documented achievements, the authors mean participation in competitions (e.g., mathematics, languages, art, etc.), tournaments, contests, and competitions on knowledge.

equipment was severe, so the child had to use mobile devices. The respondents also declared other organizational problems impeding communication, such as distractions in the form of renovation, noise, remote work of parents or younger siblings (21 people, 2.9%) and the lack of a permanent place for learning and communication (8 people, 1.1%). Almost a quarter of respondents (169 people, 23.7%) did not declare any organizational problems related to the child's remote education and communication.

The results show that less than half of the respondents' children (324 people, 45.5%) had comfortable conditions for communicating on their own computer and in their own room, while maintaining privacy. This percentage drops (to 188 people, 26.4%) when the need for a sufficient quality internet connection is taken into account in terms of comfort.

The vast majority of teachers (665 people, 93.4%) try to maintain a substitute for normalcy when conducting remote classes and conduct virtual meetings with the classes they teach. Of those who do not (47 people, 6.6%), 19 people transfer the obligation to teach to their parents, 18 people send materials for independent work, and 13 people use the chat[5]. This low percentage of teachers cannot be regarded as caring for high-quality communication with students. Remote classes themselves generate opportunities to reduce the continuity, intensity and quality of communication, and this manifests itself for instance in the lack of mutual stimulation of students (249 people, 35%), avoiding answering the teacher's questions (114 people, 16%), simulated attendance (64 people, 9%) and other problems such as chaos or interfering with the lesson (6 people, 0.8%).

Many teachers conducting virtual meetings with whole classes try to enrich the process of communication with students by using various forms of indirect communication. They send additional materials (269 responses, 40.5%), send tasks to be completed jointly by the student and the parent (255 responses, 38.3%), provide worksheets (201 responses, 30.2%), prepare materials and provide them (91 responses, 13.7%) or record lessons and make them available to children (37 responses, 5.6%).

The lack of direct contacts and the transfer of communication to the virtual space had a significant impact on many aspects of the child's functioning as a student. The analysis with a student's t-test for one sample showed that in the studied sample, the mean of comparative grades of selected elements common for remote and traditional education is statistically significantly lower than the value 3 (the value 3 was assumed as a value indicating that when assessing the elements of education, the parents of gifted students assigned them the value *The same in traditional and remote education* on a five-point scale). The obtained results show that parents assessed contact with teachers, a child's activity, and peer relations more highly in the setting of full-time, traditional education.

The problems identified by parents relating to remote learning, but also disruptions in communication processes included students disrupting lessons, "disconnecting" from an activity, or stress related to technical problems that affect communication with the teacher.

"Easy withdrawal from activity by turning off the camera and microphone" (guardian 832).

"Communication problem with the teacher who did not always hear the questions, the child sometimes did not know what to do" (guardian 855).

"Chaos during the lesson (...) loud conversations, cross-talking – difficulty focusing, feeling lost (what should I do now, what page in the textbook, what task...), additional background noises (younger siblings, but also parents giving instructions to children) – these are definitely not the conditions for learning" (guardian 1281).

"Stress resulting from technical problems – e.g. will the teacher hear?" (guardian 2045).

Parents also noticed the advantages of distance learning and mediated communication, independent of the child's place and health situation, or the need for other adults to care for the child.

"(...) when a child is slightly ill, he or she can attend classes, in order to participate in classes, he or she does not have to stay in the same place, i.e. at home, if he has a problem during classes, he may ask a parent for help" (guardian 885).

Table 3

Selected Aspects of Communication During Social Isolation

	*t**	*df*	Significance (two-tailed)	Mean difference	Upper limit**	Lower limit**
Child activity	–34.23	711	0.000	–1.20	–1.27	–1.13
Contact with teachers	–48.33	711	0.000	–1.48	–1.54	–1.42
Peer relationships	–64.80	711	0.000	–1.68	–1.74	–1.63

Note. * One-sample t-test, test value = 3.

** 95% confidence interval for the difference of means.

Source: authors' own work.

[5] Multiple-choice questions were used, the answers do not add up to 100%.

Some parents pointed to the use of the possibilities offered by mediated communication and information and communication tools, the use of multiple media (film, music, presentations, graphics, etc.), improved IT competences, or developing learning competences (e.g. cognitive independence and searching for information on one's own), which have an impact on learning processes and make it possible to develop interests and abilities.

"The use of various interesting forms of presenting the topic (...), multimedia and the Internet. (...) It teaches children to search for knowledge in various places, not only from the textbook" (guardian 231).

"My daughter became more independent and responsible – she logged into the lessons herself, looked for interesting activities on the computer" (guardian 2556).

"The child's acquaintance with educational programs/platforms. Acquiring the ability to use platforms independently, for example, to learn to play chess or learn a foreign language" (guardian 373).

Remote education undoubtedly had an impact on the social competences of many students, who at that time felt lost, lonely, and suffered from a lack of peer contact. Mediated communication impoverishes relations, and in the opinion of parents, contact via the camera will not replace direct contact.

"Isolation, retardation of children's development in the social context, as well as strengthening the sense of loneliness (...)" (guardian 1430).

"(...) contact through the webcam (...) is not the same as at school" (guardian 1730).

As mentioned, the teachers tried to diversify the online lessons. They tried to keep students' interest and activity in the classroom by using various forms of indirect communication and using the possibilities offered by the Internet and IT tools. This form of communication also made it possible to reduce some communication noises that children experienced in the classroom, i.e., noise, distraction by other students, or jamming the teacher. At home, the child could focus on what the teacher was saying, did not feel pressure from other students, did not hear their comments and did not see the reaction (non-verbal and verbal messages) to what he had just said. It made it possible for students to open up more and increase their activity during online lessons.

"The student was not afraid of the teacher, he was not ashamed of the class, which made him more active during the lessons (...)" (guardian 258).

"My child could focus on the content and knowledge provided by the teacher and was not distracted by his colleagues, because he only saw the teacher on the screen most of the time (...)" (guardian 631).

"(...) the son overcame his shyness through remote learning, the teacher during these classes paid attention to each student and encouraged them to speak, no student was omitted, everyone worked as one well-coordinated group (...)" (guardian 2115).

There were many statements about the limitation of contacts and the regression of social competences but few statements about the possibility of maintaining relationships and maintaining daily contact and conversations between students and the teacher.

"Daily opportunity to see friends (...)" (guardian 506).

"The children did their homework together by connecting via the computer (...)" (guardian 887).

"Contact with the teacher online – almost face to face, contact with peers" (guardian 1139).

Single parents appreciated the efforts and contribution of teachers to this form of learning and communication with students.

"The most important advantage of distance learning is the fact that the teacher is very committed to raising the level of teaching in these very unfavorable conditions" (guardian 965).

"My son has a teacher by vocation, so these lessons really did not differ from those in school (...)" (guardian 2284).

Another disturbing aspect arising from the parents' statements is the lack of self-reliance in the work of students, self-regulation in learning, but also the revealed attitudes of parents who teach their children from an early age that if they do not know something or are unable to do so, others can do it for or instead of them. Instead of teaching children independence in learning and searching for information, they provide them with ready-made solutions, which not only is not conducive to the development of the student but also undermines willingness and cognitive curiosity, so important in developing skills.

"(...) Many parents told their children what was going on and what disturbed their learning (...)" (guardian 1730).

Summary and Discussion of the Results

Effective work with gifted students requires appropriate competences (Romaniuk & Jabłonowska, 2022). In educational situations, communication is a key issue for understanding and describing, as well as the educational impact, which Morreale, Spitzberg, and Barge understand is about organizing and communicating messages in such a way as to give them a specific meaning. Communication competences provide a framework for making choices about how to communicate to build strong relationships and perform tasks (Morreale et al., 2007). McLuhan believes that the medium is more important than the message itself, as it shapes and controls the scale and form of interpersonal relations as well as human activities (McLuhan, 2005).

In fact, the same content communicated through different media changes its meaning. In the face of the pandemic and school closure, teachers faced an enormous challenge. They had to replace the existing proven forms and methods of work and methods of communication with forms of remote work and mediated communication. At that time, teachers mainly chose video meetings during which they conducted lessons from among the available forms.

Often, these meetings were supplemented with additional materials sent for independent work, interactive exercises, shared videos, and content related to the topics discussed, or graphic materials. We can see comparable results in the texts of other authors (Buchner & Wierzbicka, 2020; Omyła-Rudzka, 2021). Some parents appreciated the teachers' contribution to making the classes more attractive and maintaining children's interest and activity during online lessons through the use of interesting forms of presenting the topic, using multimedia, films, music and presentations. Many parents believed that nothing and no one could replace the teacher, and the lessons taught in the classroom.

While the systemic support for gifted students was visible before the pandemic (Łukasiewicz-Wieleba & Romaniuk, 2020), the surveyed parents did not mention it in their statements regarding remote education during the crisis. The burden of learning self-regulation in learning or developing skills by limiting social contacts and changing the manner of communication rested with parents and guardians. There is also no individualization of communication with a gifted student. No attempts to establish additional contacts for capacity development were indicated. Neither solutions nor possibilities for enhancing the development of social abilities through indirect communication were mentioned.

Gifted students were left on their own to develop their abilities and treated in the same way as the rest in terms of communication. Strengthening IT competences came at the expense of social competences, and therefore communication skills. Communication via computer has been reevaluated and reduced to the functionality of the technical transmission of information, without the emotional charge and nuances of non-verbal communication. In the case of the analyzed group of children in early childhood education, depriving them of the possibility of being in a peer group for such a long time may result in far-reaching, negative consequences.

Transferring communication to a virtual space, where interactive communication between the school community was not interpersonal in nature, and there was no direct contact and non-verbal elements, created a space for dishonest communication, avoiding contact with the teacher (Kaźmierska, 2019; Maj, 2008) or for children to be helped by their parents (Trzcińska-Król et al., 2021). In the described research, parents pointed to avoiding the teacher's questions, simulating presence in online lessons, lack of mutual stimulation of students or lack of independence and self-regulation in learning. Despite the teachers' efforts to cope with distance education and to maintain some normality by conducting virtual meetings with the class, the parents formed a poorer opinion of the contact with teachers, the child's activity, and peer relations when learning took place using indirect communication means. Only a few parents saw value in this form of communication, in which it is possible to maintain contact with the teacher and peers.

The barriers and errors in mediated communication include problems with signal transmission, broadcaster problems, problems with coding, problems with receiving and decoding information and problems with understanding and answering (Jagieła, 2004). The main difficulties connected with remote education were technical problems with the Internet connection and in the case of one in five children of respondents – the hardware enabling communication with the teacher and participation in the lesson, or software. Comparable results were obtained in the CEBOS study (Omyła-Rudzka, 2021). In the presented research, the respondents also pointed to other communication noises that hinder the understanding of messages and the answer. In this regard, they listed: sounds made by younger siblings, the sound of renovation, noise, or the sound of remote work of parents. A barrier the respondents also indicated was lack of a permanent place to learn and communicate. Only 26.4% of the children of the surveyed parents had comfortable conditions for communicating with the teacher and actively participating in the lessons. This was facilitated by having your own computer, working in your own room, maintaining privacy, and having a decent quality internet connection.

The presented research reveals many problems and disadvantages associated with communication in remote education. Almost one in three tutors of a student with grades 1–3 do not see any advantages of remote education. There are few works that discuss the positive aspects of this form of education. Pyżalski's research shows that only about 5% of children actually benefited from this form of education (Pyżalski, 2021). Despite the increase in access to knowledge through remote education, the social costs of isolation related to the inability to conduct direct communication turned out to be too high.

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More than Socio- and Geo-demographics: How Complementary Education and Business Experience Shape Students' Financial Behaviour in Europe

Abstract

Although financial literacy would seem relevant to university students' education, it is not currently offered as a transversal subject within European academic curricula. It should therefore come as no surprise that a common solution are ad-hoc specific courses, with students often additionally acquiring valuable learning through their own experiences in business environments. With this and the recent literature on the drivers of financial literacy in mind, the authors decided to explore the context shaped by socio-demographic, academic and work-related factors that either promote or prevent European university students from developing appropriate financial skills, such as managing personal finances, planning for short- and long-term needs, and distinguishing among different sources of non-traditional funding. The study used a sample of 881 undergraduate and postgraduate university students from Romania, Poland and Spain from different studies, with information obtained through an anonymous online survey. The applied econometric model was cumulative regression with location-scale estimation using the R software, version 4.3.2, with variables associated directly with the development of basic financial skills being age, gender, country, but also specific training as well as work and entrepreneurial experience. The authors stress the importance of providing financial management education connected to the reality, especially the business and entrepreneurial environment.

Keywords: university students, entrepreneurial experience, non-traditional funding, personal finance management,+ cumulative regression

Introduction

Several studies worldwide show that proper financial behaviour, understood as behaviour related to money management (Xiao, 2016), is directly influenced by proper financial education and literacy (Bruhn et al., 2016; Kaiser & Menkhoff, 2020; Wagner & Walstad, 2018). This question is especially relevant for university students for three main reasons. Firstly, financial education as such is not included as a defined block of studies in any official undergraduate or postgraduate university degree in the European Union. Secondly, university students are becoming increasingly economically and financially independent, which involves the need to deal with financial questions. According to the definition proposed by the OECD (2024, p. 6), the term "financial literacy" means "a combination of financial awareness, knowledge, skills, attitudes and behaviours necessary to make sound financial decisions and ultimately achieve individual financial well-being". Thirdly, the higher education environment is meant to foster the entrepreneurial spirit of university students (Valencia-Arias et al., 2022), greatly influencing the development of entrepreneurial skills (Ferreras-Garcia et al., 2021). Therefore, the support provided to them should also include financial education and guidance adapted to entrepreneurship.

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The majority of studies attempt to identify the level of financial knowledge of university students, assessed from a theoretical perspective by applying specific tests to measure the financial literacy of young adults. However, little attention is paid to analysing the financial attitudes and financial behaviour of this group, which is not always evident and requires a different approach in order to measure them properly. Potrich et al. (2016) explain that financial attitudes play an important role, influencing decision-making in terms of finances, while Yahaya et al. (2019) go even further, pointing out that it is financial attitudes and not so much financial knowledge that have a significant impact on students' financial behaviour.

The latter concept is extremely important as it refers to an action that can be interpreted as appropriate behaviour of a person in terms of managing personal finances (Ingale & Paluri, 2022; Potrich et al., 2016) and implies individual responsibility by using different economic and financial resources to meet certain (personal) goals (Sugiyanto et al., 2019). Financial management is reflected in knowing how to plan, budget, control and search for financial funds to cover personal needs (Herdjiono et al., 2018). In this regard, this question is considered critical for university students as young adults and potential labour market players, recognising financial literacy as one of the core elements to be thoroughly analysed in order to obtain a clearer picture of what should be amended in the current proposals and practice of financial education.

Based on the literature review, an empirical study is pertinent to analyse financial literacy through the perception of certain basic financial skills among students of Spanish, Polish and Romanian universities, with the skills under analysis being those related to management (managing personal finances), planning (planning short- and long-term financial needs), and understanding new forms of financing as an alternative way to finance entrepreneurial initiatives (distinguishing among non-traditional sources of finance). The main objective is to determine the likelihood at which different factors, such as socio-demographic characteristics as well as academic and employment background, are related to these skills. We hypothesise that age, gender and specific training in finance significantly influence the personal financial management skills of European university students, and further anticipate a notable impact from their work and entrepreneurial experience. These expected results are regardless of the country of study, as in most of them the level of financial literacy is quite low.

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The structure of this work is as follows: first, a literature review is offered through which the authors provide evidence on the importance of different factors related to the objective of the study; second, the applied methodology together with the econometric models is explained, along with a description of the sample and the variables; third, the findings are presented; and fourth, the discussion and conclusions are outlined.

Literature Review

The OECD study was one of the first to highlight the importance of financial literacy, included in the OECD PISA assessment of 15-year-old students since 2012 (OECD, 2014), and the need to develop financial education policies and programmes in the early 21st century. With the importance of financial literacy becoming widespread, the developed methodology for the assessment of financial literacy started to be a kind of universal template for further studies. Following this initiative, many research studies, led by international organisations as well as academic researchers, focus on different questions ranging from assessing financial knowledge to measuring the effectiveness of learning methods, or the impact of financial knowledge on individuals' behaviour, well-being and, finally, on the macroeconomy of the country (Fornero & Prete, 2023; Lusardi & Messy, 2023).

The focus on the younger population, such as university students, can be seen not only in institutional reports but also in the academic literature. Most studies are related to measuring the level of financial literacy for which special test toolkits are used (Dahiya et al., 2023; Katenova & Lee, 2018; Pavković et al., 2018), while research findings, in their majority, are carried out with a sample of a particular country, with only a few including more than one country (Ergün, 2018; Polák, 2020). Existing research extends beyond the measurement of financial knowledge, analysing its relations with financial behaviour and attitudes (Chmelíková, 2015; Ingale & Paluri, 2022; Mireku et al., 2023; Owusu et al., 2023).

Academic research analyses certain demographic characteristics, such as gender or age and their relationship with university students' financial behaviour (Ergün, 2018; Khalisharani et al., 2022; Susanti & Hardini, 2018), with age generally related to life experience, which translates into enhanced financial knowledge in years and experience (Mitchell & Lusardi, 2022), with older university students tending to be more skilful in managing personal finances (del Rosario Arambulo-Dolorier et al., 2024; Lusardi, 2019). The following hypothesis is therefore proposed:

H1: Older university students are more likely to be highly skilled in managing personal finance.

With gender in mind, it should be noted that the results are contradictory in the case of female participants, with most studies aimed at gender relations and financial behaviour pointing out that in general, women have lower financial literacy, resulting in their decision-making being different (Garg & Singh, 2018; García Mata, 2021; Wee & Goy, 2022). On the

other hand, other studies focused on the segment of university students do not provide evidence that gender plays a critical role in assessing the financial knowledge and decision-making of female students (Demirgüç-Kunt, 2021; Susanti & Hardini, 2018). Moreover, recent studies show that women are more likely than men to set financial goals and create financial security plans (Liu, 2021), and tend to exhibit better financial attitudes and behaviours, despite potentially having less financial knowledge (Gudjonsson et al., 2022). The following is proposed accordingly:

H2: The likelihood of managing personal finance successfully is higher among female university students.

Reports published by the OECD (2017; 2020) repeatedly show students' lack of basic financial knowledge, demonstrating that they struggle to apply successfully financial concepts to real-life situations. Surprisingly, a lack of financial understanding characterises both countries with weak as well as developed economies (G7 and G20). The differences found generally refer to other aspects, such as immigrant background, gender, etc., with most countries showing a rather low level of financial literacy among young people, including university students (Lusardi & Messy, 2023). The following hypothesis is therefore formulated:

H3: The relationship between the country where university students study and their skills in managing personal finance is not significant.

According to the definition of financial literacy proposed by the OECD (2024), it is not only financial awareness but also experience that matters. Supposedly, the more practical experience with financial matters the greater the knowledge (Ergün, 2021), meaning that theoretical knowledge is important, but insufficient. The importance of actual experience in the business world via employment contracts or entrepreneurship should be stressed in this case. Previous financial experience, generally acquired through work experience, is much more beneficial than specific courses when it comes to proper financial decision-making (Chabaefe & Qutieshat, 2024), contributing to healthier financial behaviour of young people (Nano & Mema, 2017). This idea is also supported by other studies (see Ahmaddien et al., 2019; Andreeva et al., 2020; Johan et al., 2021). Thus, the following hypotheses are proposed:

H4: Specific financial literacy training increases the likelihood that university students will successfully manage their personal finances.

H5: University students' work experience increases the likelihood of managing their personal finances successfully.

It is also relevant to consider that financial behaviour is formed through consumption, entrepreneurship and finance management (Narmaditya & Sahid, 2023), although there is limited research examining how prior entrepreneurial experience enhances the financial behaviour or skills of young adults, with only a few studies indirectly suggesting that this might be so if one interprets 'prior financial responsibility' (Harrington et al., 2016) or 'financial management training' (Kirsten, 2018) as part of entrepreneurial experience, which is somewhat subjective. When someone starts their own business with prior experience in various projects, they naturally acquire a certain level of financial knowledge during the process, which is crucial and positively influences the entrepreneur's financial attitude, leading to more rational financial decision-making (Okičić, 2019). The following is therefore formulated:

H6: University students with an entrepreneurial background are more likely to manage personal finance successfully.

It is important to note that effective personal financial management, including both short- and long-term financial planning, involves, among others, the ability to identify necessary financial funds - not only traditional ones but also increasingly prevalent alternative forms of financing (Bonini et al., 2019). This is especially true when it comes to emerging business proposals or personal projects (studies, sports, culture) that require strong financial backing but experience difficulties in accessing traditional funding (Cho & Lee, 2018; Huth & Kurscheidt, 2022). Alternative financing, most suitable for entrepreneurs, refers to venture capital, any form of private equity, or loans (peer-to-peer lending) to which business angels or crowdfunding are related (Cumming & Johan, 2017). In several US states, schools have introduced specific training, with alternative financing as part of personal financial management (Harvey, 2019). Aware of the lack of knowledge of university students of alternative financing and encouraging entrepreneurship among young people, Audretsch (2017) suggests that they should have contact with real investors to improve this gap.

Methodology

The study used an anonymous online survey conducted at universities in Spain, Romania and Poland, with adult university students duly informed about the research purpose, providing consent to participate by answering the questions. The educational institutions were not therefore required to undergo the specific procedure for obtaining authorisation from the respective Ethics Committees, nor did this entail any responsibility under the Organic Law on Data Protection, Data Custody, and ARCO rights.

The questionnaire includes different blocs of questions that help to describe the sample and identify the relationship among different variables. For this study, the focus is placed on questions that provide categorical variables, treated in the analysis as independent, and ordinal variables, treated as dependent. The first bloc of questions refers to the following variables: gender; age; country of study at the moment of the survey; academic level distinguishing between under- and postgraduates; additional specific studies, typically short-term courses in entrepreneurship (delivered in traditional and digital format) and in financing;

work or internship experience; and entrepreneurial experience. All these questions collect responses on a nominal scale, except for age, which is on a ratio scale. The second bloc of the questionnaire includes a large number of different statements related to different skills relevant to financial literacy. All the statements implied answers using a seven-point Likert scale, with 1 as "totally disagree" and 7 as "totally agree". The questionnaire used for this study is offered in Appendix 1.

Given the space limitations of this paper and the extensive output generated by applying econometric models to each variable, only four dependent variables were selected for this research, corresponding to basic financial skills and contributing to successful financial management: (a) ability to manage personal finances; (b) confidence in planning effectively for future financial needs in the short term; (c) confidence in planning effectively for future financial needs in the long term; (d) ability to differentiate among different non-traditional financing sources. These manifestations are at the root of financial behaviour, as analysed by different researchers (Andarsari & Ningtyas, 2019; Huang, 2016; Khalisharani et al., 2022), so it therefore seems appropriate to start analysing what shapes university students' financial behaviour to offer effective measures that would lead to the right financial attitude and decision-making to help achieve greater financial stability.

The sample includes 881 university students from Poland, Romania and Spain, mainly between the ages of 18 and 23, studying at different undergraduate and postgraduate (Master's and PhD) levels. The selection of countries is in line with the project framework, in which universities from Poland, Romania and Spain participated. Nearly 13% of respondents study in Spain, about one-third in Poland, and 57% in Romania. The majority of respondents are female (68%), about a third are male (30%), and a minority (1.7%) of students do not identify themselves with any of the binary genders or prefer not to answer. The vast majority of participants are undergraduates (95%), of which seven out of ten study Economics and Business Administration. Approximately 8% of the undergraduates study Law and Political Science or Engineering, which also includes Exact Sciences. A smaller percentage, around 3%, are in Education, Humanities and Social Sciences, while the rest of the participants declared to have been studying Master or Ph.D. programmes, mainly focused on Economics and Business Administration.

Regarding the students' previous background as additional specific training and work experience, only one-third part of the sample had taken additional courses, either in traditional or digital format. In the case of longer specific studies, this percentage is lower by 6 points. Approximately half of the participants claim work experience through an employment contract or internship. Finally, approximately 10% of the participants are entrepreneurs, quite balanced between experienced entrepreneurs with at least one business created and entrepreneurs who were creating their company at the moment of the survey. All this information is presented in Table 1.

Given the nature of the dependent variables, which assess various financial skills on an ordinal scale, a cumulative ordinal logistic model is employed. Within the taxonomy of ordinal regression models, cumulative models are based on the assumption that there is an underlying latent regression with a continuous dependent variable (McCullagh, 1980; Tutz, 2022) defined by the following equation (1):

$$Y_i = x_i^T \beta + \epsilon_i, \ \ i = 1, \dots, n; \tag{1}$$

Where Y_i is the *i*-th observation of the dependent variable; x_i^T is the transpose vector of observations of the explanatory variables for the *i*-th individual; β is the vector of associated parameters relating each explanatory variable to the dependent variable, and ϵ_i is the error term with a continuous distribution. Scale-ordinal observations can be represented given a random variable that takes a value if the *i*-th observation of the dependent variable belongs to the *k*-th category, where k = 1, …, 7. The general cumulative model, corresponding to the underlying model in equation (1), can be expressed as follows (equation (2)):

$$P(Y_i \leq k) = F(\beta_{0k} + x_i^T \beta); \ i = 1, \dots, n; \ \ k = 1, \dots, 7; \tag{2}$$

Where Y_i is the value of the dependent variable for the *i*-th individual and β_{0k} are the thresholds, also called intercepts, for the *k*-th level that should be ordered. x_i^T and β are defined as in equation (1), and the link function (F) used is the logistic function. Regarding the collected data, it is worth noting that they proceed from the answers of the participants with different characteristics and backgrounds, with one of the main problems encountered in the estimation of model (2) being the potential heterogeneity in the population, which can lead to inconsistent results (Tutz, 2022). To reflect this reality and optimise the model, the estimation of a location-scale cumulative ordered model is proposed as an alternative to nominal effects, which collect different thresholds dependent on other regressors when the data contains non-proportional probability structures. These are considered more robust, since the model is accurately defined for all values of the explanatory variables, regardless of the translocation and scaling of the covariates (Christensen, 2018).

Additionally, a scale test is applied to identify the variables that can create significant heterogeneity within the model, helping to determine whether the relationship between the independent and dependent variables is the same for all categories. To perform the scale test, two nested models are compared: a full model that includes all the independent variables and a restricted model that excludes one or more of the independent variables, with the test statistics for the scale test based on the difference in log-likeli-

Table 1
Descriptive Statistics of the Sample, in % of the Total

Socio-demographics							
Gender	**%**	**Age**	**%**	**Country of studies**	**%**	**Academic level**	**%**
Female	68.3	18–22	68.8	Poland	29.6	Undergraduate	95.1
Male	30.0	23–30	22.1	Romania	57.7	Postgraduate	4.9
Other	1.7	31–40	6.0	Spain	12.7		
		>41	3.1				
Total	100		100		100		100
Educational background							
Formal studies		**%**		**Traditional courses**			**%**
Economics		72.9		Yes			14.8
Engineering		8.4		No			85.2
Law and Politics		7.3		Digital courses			%
Humanities		3.4		Yes			17.3
Education		3.1		No			82.7
Social Sciences		3.1		Specific studies			%
Exact Studies		1.1		Yes			26.2
Health		0.6		No			73.8
Audiovisual Communication		0.2					
Total		100					100
Work and business experience							
Work experience	**%**	**Internship experience**	**%**	**Set up a business**	**%**	**Setting up a business now**	**%**
Yes	54.9	Yes	48.2	Yes	5.4	Yes	5.6
No	45.1	No	51.8	No	94.6	No	94.4

Source: authors' own work.

hoods between the full and the restricted models. Finally, the cumulative ordinal location-scale model can be rewritten using equation (2), which delivers equation (3):

$$P(Y_i \leq k) = F\left(\frac{\beta_{0k} + x_i^T \beta}{z_i^T \alpha}\right);\ i = 1, \ldots, n;\ k = 1, \ldots, 7; \tag{3}$$

The variables that generate heterogeneity are collected in the transposed vector z_i^T for the *i*-th observation, and α is the vector of parameters associated with these variables. After estimating the models, an ANOVA/log-likelihood test is applied to check the robustness of the estimation made with the models defined in equation (3), which helps to detect whether the cumulative location-scale model improves the explanatory capacity of the dependent variable, comparing models (2) and (3).

Considering the methodology described and the nature of the dependent and independent variables, four models were estimated to determine the effectiveness of geodemographic characteristics of the participants, as well as the factors related to education and business experience on the perceived level of financial literacy of university students. These models correspond to equation (4):

$$\begin{aligned} P(Y_{il} \leq k) = F\,(&\beta_{0k} + \beta_1 Age_i + \beta_2 Gender_i + \beta_3 Studies_i + \\ &+ \beta_4 Ac.Level_i + \beta_5 Country_i + \beta_6 Traditional_i + \\ &+ \beta_7 Digital_i + \beta_8 Intenship_i \\ &+ \beta_9 Work\ Experience_i + \\ &+ \beta_{10} Business\ established_i + \\ &+ \beta_{11} Setting\ up\ Business\ now_i + \\ &+ \beta_{12} Specific\_studies_i); \\ &i = 1, \ldots, n; \quad l = 1, \ldots, 4; \quad k = 1, \ldots, 7; \end{aligned} \tag{4}$$

All the four estimated models, each corresponding to one of the proposed financial skills, use a different dependent variable, but the same regressors. In the first model (a), the ordinal dependent variable Y_{i1} gives information on the ability to manage their personal finances; in the second model (b), the de-

pendent variable Y_{i2} assesses whether the student is able to effectively plan for short-term financial needs; in the third model (c), the dependent variable Y_{i3} evaluates the skill to effectively plan for long-term financial needs; and in the fourth model (d), Y_{i4} assesses the student's ability to distinguish among different sources of non-traditional financing.

Age is the age of the respondents at the moment of the survey. *Gender* indicates the gender with which the students identified most. The variable *Studies* refers to the university (long-term) studying programmes in which the students are enrolled. *Ac.Level* stands for undergraduate or postgraduate studies. *Country* refers to the country of study at the moment of the survey. *Traditional* refers to specific short courses in entrepreneurship taken in a traditional face-to-face format. *Digital* refers to specific short courses in entrepreneurship taken in a digital format (synchronous or asynchronous). *Internship* refers to work experience through an internship contract. *Work experience* refers experience through a part- or full-time contract. *Business established* implies entrepreneurial experience in the past. *Setting up Business now* refers to setting up a company at the moment of the survey. *Specific studies* stands for specific courses or seminars on financial management. β_1–β_{12} are the coefficients associated with the above-mentioned independent variables, and β_0 is the intercept. The descriptive statistics of the independent variables are provided in Table 1, while the statistics of the dependent variables are shown in Table 2.

As a final note on the model variables, it should be emphasised that in the context of this study, which draws on a sample of university students, the inclusion of the above-mentioned independent variables,

Table 2

Descriptive Statistics of Dependent Variables used in the Estimation Model

Model (a): Managing personal finances			Model (b): Planning finances in the short-term		
Scale	**Responses, *N***	**Responses, %**	**Scale**	**Responses, *N***	**Responses, %**
1	20	2.3	1	19	2.2
2	29	3.3	2	46	5.2
3	79	9.0	3	109	12.4
4	127	14.4	4	184	20.9
5	217	24.6	5	206	23.4
6	220	25.0	6	166	18.8
7	189	21.5	7	151	17.1
Total	881	100	Total	881	100
Model (c): Planning finance in the long-term			**Model (d): Distinguishing among non-traditional funding sources**		
Scale	**Responses, *N***	**Responses, %**	**Scale**	**Responses, *N***	**Responses, %**
1	30	3.4	1	163	18.5
2	56	6.4	2	146	16.6
3	87	9.9	3	162	18.4
4	184	20.9	4	208	23.6
5	216	24.5	5	122	13.8
6	170	19.3	6	52	5.9
7	138	15.7	7	28	3.2
Total	881	100	Total	881	100

Descriptive statistics				
	(a) Managing personal finances	**(b) Planning finances in the short-term**	**(c) Planning finances in the long-term**	**(d) Distinguish non-traditional funding sources**
Mean	5.17	4.83	4.77	3.28
Median	5	5	5	3
St. Dev.	1.5	1.54	1.58	1.63
Min	1	1	1	1
Max	7	7	7	7

Source: authors' own work.

spanning socio-demographic, geo-demographic and topic-specific dimensions, is both intentional and theoretically grounded. Their selection reflects the need to capture the multifaceted nature of the phenomenon under investigation and ensures that the model remains valid and reflective of real-world dynamics.

The statistical analysis was done using R free software, version 4.3.2.

Findings

The results of the four estimations are shown in Table 3.

Table 3

Estimation Results (Estimated Coefficients and their Standard Deviations)

Independent variable	(a) personal finance management		(b) short-term planning		(c) long-term planning		(d) differentiation of non-traditional funding sources	
	Coef.	St. Dev	Coef.	St. Dev	Coef.	St. Dev	Coef.	St. Dev
Age	0.0492	(0.0129)***	0.0374	(0.0119)***	0.0375	(0.0111)***	0.0492	(0.0197)**
Gender [M]	–0.3292	(0.1434)**	0.1510	(0.1351)	0.0135	(0.1337)	0.3320	(0.1971)*
Gender [Others]	–0.6806	(0.4800)	–0.7114	(0.2807)**	–10098	(0.4427)**	0.6941	(0.5745)
Studies [Economics]	–0.1721	(1.0718)	–0.7767	(0.9931)	–0.2542	(1.0933)	–0.4466	(1.4872)
Studies [Education]	–0.7907	(1.1130)	–16201	(1.0374)	–0.9844	(1.1393)	–2.3029	(1.5834)
Studies [Engineering]	–0.1815	(1.0811)	–10781	(1.0017)	–0.8300	(1.1006)	–1.5497	(1.5078)
Studies [Exact sciences]	0.3978	(1.2274)	–0.5513	(1.1489)	0.4689	(1.2439)	–0.8201	(1.6336)
Studies [Health Studies]	–0.5673	(1.3227)	0.3067	(1.2713)	0.9778	(1.2739)	–0.0655	(1.9109)
Studies [Humanities]	–1.0780	(1.1134)	–16319	(1.0341)	–12957	(1.1341)	–2.5431	(1.5768)
Studies [Law and Politics]	–0.3780	(1.0986)	–0.8555	(1.0173)	–0.8945	(1.1206)	–1.1898	(1.5255)
Studies [Social Sciences]	–0.5162	(1.1221)	–0.8867	(1.0417)	–0.7807	(1.1395)	–0.9559	(1.5439)
Country [Romania]	0.1563	(0.1672)	–0.4118	(0.1583)***	0.0898	(0.1568)	–0.8489	(0.2400)***
Country [Spain]	–0.4203	(0.2297)*	–0.8591	(0.2160)***	–0.5174	(0.2149)**	–1.5082	(0.3581)***
Ac.level [Postgrad]	–0.2213	(0.2901)	0.0629	(0.2716)	0.2188	(0.2586)	0.7098	(0.4104)*
Traditional [Yes]	0.4311	(0.1807)**	0.7018	(0.1729)***	0.4017	(0.1533)***	0.8481	(0.2586)***
Digital [Yes]	0.5925	(0.1759)***	0.4898	(0.1603)***	0.7154	(0.1649)***	1.0950	(0.2644)***
Internship [Yes]	0.3399	(0.1266)***	0.2018	(0.1184)*	0.1753	(0.1173)	0.3901	(0.1687)**
Work experience [Yes]	0.2890	(0.1331)**	–0.0020	(0.1259)	0.1563	(0.1244)	0.5283	(0.1842)***
Business established [Yes]	0.6551	(0.2839)**	0.1736	(0.2632)	0.3745	(0.1965)*	0.2453	(0.3963)
Setting up business now [Yes]	0.6885	(0.2917)**	0.6035	(0.2643)**	0.6772	(0.2387)***	1.1139	(0.3921)***
Specific Studies [Yes]	–0.0442	(0.1495)	0.0423	(0.1409)	0.2235	(0.1350)*	0.2322	(0.1906)

Note. The coefficient and standard deviation of each variable is shown in brackets;
*** means a significance level of 1%,
** means a significance level of 5%,
* means a significance level of 10%.

Source: authors' own work.

In the first estimation (a), focused on the students' ability to manage personal finances, the results deliver a significant number of independent variables as significant. *Age* has a positive coefficient and is significant at 1%, meaning that the greater the age, the higher the probability of success in managing personal finances. *Gender (M)*, which corresponds to male participants, has a negative sign and is significant at 5%. This variable is categorical, so the effect measured reflects the difference between male and female students. *Country (Spain)*, another categorical variable referring to Spanish students compared to Polish ones, is significant at 10% with a negative coefficient. In this case, Spanish students are less likely to have well-developed personal financial management skills compared to Poles. *Country (Romania)*, a categorical variable that helps to compare Romanian and Polish students, is not significant, so it is not very clear whether Romanians or Poles are stronger in personal finance management.

The variables *Traditional (Yes)* and *Digital (Yes)* are significant at 5% and 1%, respectively, both with a positive coefficient, which means that specific short courses in entrepreneurship, delivered in traditional and digital formats, significantly enhance students' chances of developing strong personal financial management skills. *Internship (Yes)*, *Work experience (Yes)*, *Business established (Yes)* and *Setting up business now (Yes)* are other independent variables that are significant and all positive, which underscores the notion that hands-on experience in a professional setting–whether through internships, employment or entrepreneurship–plays a crucial role in achieving success in personal finance management. The rest of the variables, as observed in the table, are not significant, so their influence is not relevant to the ability of personal finance management.

To improve the estimation of (a), a scale test is applied to determine if any of the independent variables generate high heterogeneity. The results show that *Gender (M)*, *Internship (Yes)* and *Business established (Yes)* are significant. Comparing the first model with and without the scale test through ANOVA, significant differences between the two models are detected. In the second model, the scale test contributes to the explanatory capacity of the model, making it more robust and optimised. These results partially support the proposed hypotheses, except for H3, which states that there are no significant differences among students from different countries. In our case, Polish students are more likely to be more successful in managing personal finances than those from Spain.

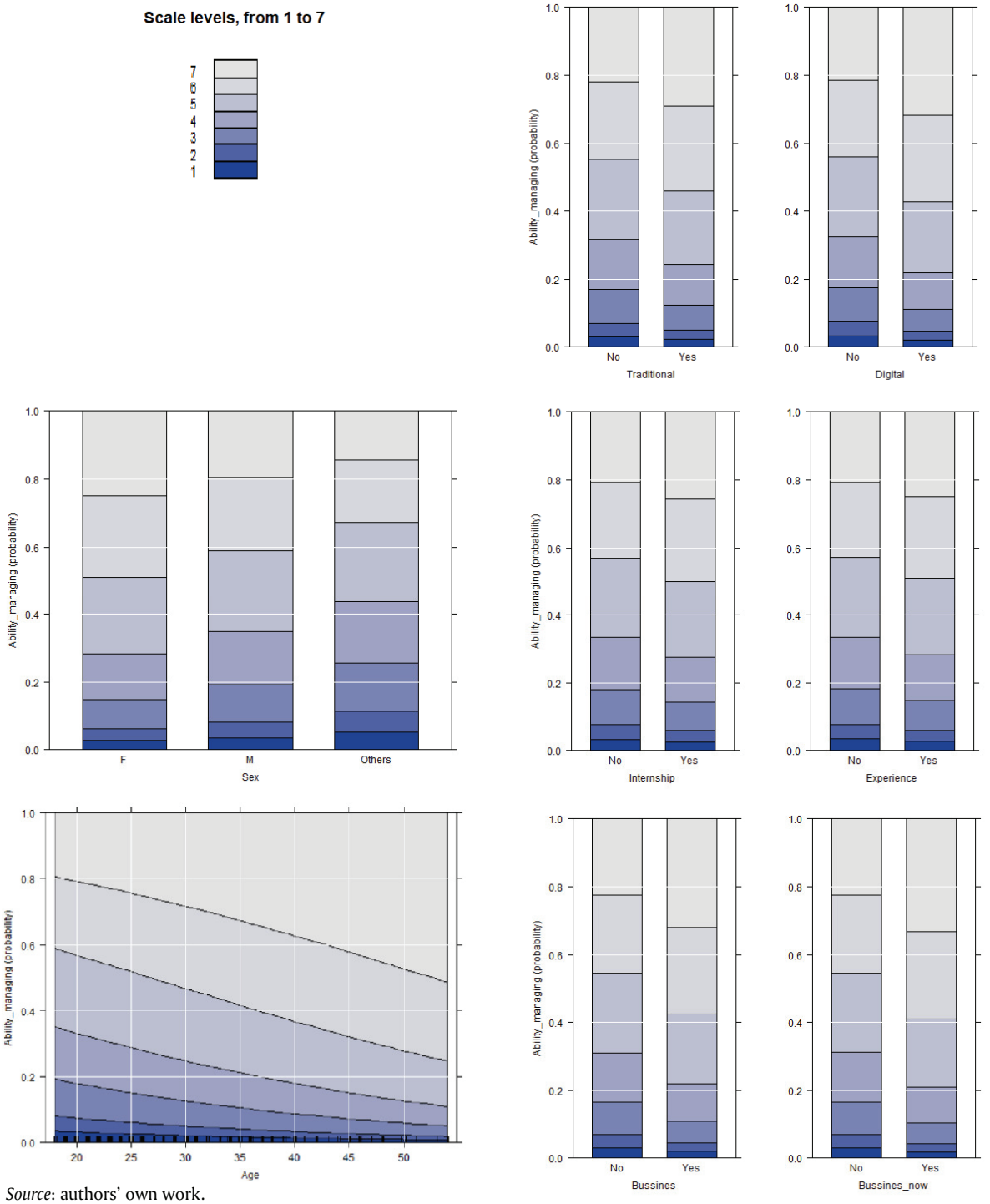
Additionally, there are several charts obtained from the estimation of model (a), showing the predictor effect of the significant independent variables on the development of personal financial management skills (see Figure 1). The complete figure contains different graphs, each corresponding to an independent variable identified as significant in the model estimation (a), and allowing for a comparison of participants' responses across the different variables. For instance, the variable *Traditional (Yes)*, which refers to whether participants have taken a traditional course ('yes' and 'no'), shows the effects using a colour gradient (ranging from dark blue for weaker influence to lighter blue for stronger influence). These colours represent the levels of a 1 to 7 Likert scale used to measure self-reported personal finance management skills. As shown, the influence range (i.e. the height of the bars), particularly for the top three scale levels, is greater among participants who have taken a traditional course compared to those who have not. This pattern of interpretation applies similarly to the other graphs included in Figure 1.

In model (b), which assesses planning skills of university students for short-term financial needs, *Age* comes out significant and positive, suggesting that as in the previous model, older students are more likely to have stronger skills in short-term financial planning. The variables *Gender (Others)*, *Country (Romania)* and *Country (Spain)* are significant, with a negative coefficient. University students of non-binary gender and those studying in Romania and Spain compared to Poland are therefore likely to be less skilled in short-term financial planning. *Traditional (Yes)*, *Digital (Yes)*, *Internship (Yes)* and *Setting up business now (Yes)* are significant and positive. Similar to the results of model (a), the experience the students had through specific business courses (traditional and digital), internships and setting up a business at the moment of the survey are likely to be more successful by planning for short-term financial needs.

The application of the scale test shows that the variable *Gender* is the only one that generates the greatest variability in the model. Once again, after comparing the models with and without the scaling test, the estimation with the scaling test is significant, optimising the estimation of model (b) presented in this study. These findings, with the exception of H3, partially validate the proposed hypotheses as in model (a).

Estimation (c) regarding planning for long-term financial needs shows that the variables *Age*, *Gender (Others)* and *Country (Spain)* are significant, while *Age* is positive and *Gender (Others)* and *Country (Spain)* are negative. Thus, older students seem to be more successful in long-term financial planning, while students of non-binary gender and those studying in Spain are less skilled. In addition, *Traditional (Yes)*, *Digital (Yes)*, *Business established (Yes)*, *Setting up a business now (Yes)* and *Specific_studies (Yes)* are significant and positive. Specific courses in entrepreneurship, both in traditional and digital formats, specific studies on financial management, and entrepreneurial experience therefore increase the probability of showing stronger skills in planning for long-term financial needs. In this estimation, the variables with the greatest variability are *Business established (Yes)* and *Traditional (Yes)*, as shown by the scale test. Using ANOVA helps identify significant differences between models with and without scale tests, indicating that the model with scale tests is robust and optimised.

Figure 1
Predictor Effect Plot, Model (a)



Source: authors' own work.

Once again, this analysis finds partial support for all hypotheses, except H3.

The model (d), focused on the ability of students to differentiate among non-traditional sources of financing, reveals that *Age* is significant and positive, with older students, as in the three previous estimations, likely to better distinguish among the alternative funding sources. *Gender (M)* is also significant and positive, although here, unlike the result of model (a), women seem to be less skilled than men. *Country (Romania)* and *Country (Spain)* are significant with negative coefficients, which means that Spanish and Romanian students are less likely to distinguish among non-traditional funding sources than Polish students.

The variables *Ac.level (Master)*, *Traditional (Yes)*, *Digital (Yes)*, *Internship (Yes)*, *Work experience (Yes)* and *Setting up business now (Yes)* are significant and positive, meaning that those who study in Master's and PhD programmes take specific business courses (traditional and digital), while those with work and recent entrepreneurial experience likely to be quite knowledgeable about alternative funding sources. The scale test shows that in the estimation of model (d), the excessive variability is generated by the variable *Age*. As in the previous three models, the ANOVA test reveals that the model with the scale test is significant, showing the greatest explanatory capacity. These findings partially validate the hypotheses, except H2 and H3.

As in the first model (a), the remaining three models –(b), (c), and (d)– have additional charts, which, due to space constraints, are not included in this paper but are available upon request.

Discussion

This empirical study utilizes a sample drawn from three European countries, each representing different socioeconomic contexts. As shown through various official reports, financial literacy in most countries around the globe, regardless of their macroeconomic level, is quite low (Demirgüç-Kunt, 2021; Lusardi & Messy, 2023; OECD, 2020). However, the analysis of this study reveals that Polish students tend to show stronger levels of several skills associated with personal financial management than Spanish and Romanian students. Interestingly, this finding is similar to that shown by Ergün (2018) who compared the level of financial literacy among university students in eight European countries.

The finding that Polish students outperform their Romanian and Spanish peers in managing personal finance raises further reflection. There are several factors which may contribute to cross-country differences in financial behaviour. Poland, for instance, has actively integrated financial education into its national curriculum and has seen strong involvement from institutions like the National Bank of Poland in promoting financial literacy. Additionally, Poland's relatively higher GDP per capita compared to Romania, and a more stable economic trajectory in recent decades, may provide students with greater access to financial tools and knowledge. Cultural factors also play a role: for example, Poland scores higher on long-term orientation (one of Hofstede's dimensions), which aligns with prudent financial planning. The family model in Poland may encourage earlier financial independence, while Romanian and Spanish students might experience longer economic dependence on parents. Moreover, the post-communist experience in Poland differs significantly from Romania's and Spain's (Spain has a different political and economic trajectory), possibly affecting financial trust and behaviour in nuanced ways. Nevertheless, caution should be taken in extending this explanation beyond the countries studied as other national contexts are very different.

This study also highlights that specific training in finance is essential for enhancing the skills under analysis. This result is in line with the insights provided by other studies on the university student population (Aydin & Selcuk, 2019; Narmadity & Sahid, 2023). Remarkably, it is courses in business and entrepreneurship rather than studies in finance that significantly increase the probability of developing higher skills in personal financial management among university students.

Regarding gender, as expected, female students are likely to be more skilled in personal financial management than their male counterparts. This result contradicts the findings consistently reported in the literature since the early 2000s (Agnew & Cameron-Agnew, 2015; Garg & Singh, 2018; Wee & Goy, 2022). However, some studies suggest that while women may have lower financial literacy, they often demonstrate better financial practices than men (Gudjonsson et al., 2022). The only time female students seem to be less knowledgeable is about alternative funding sources. Nevertheless, it is worth noting that our study's results also reveal significant heterogeneity influenced by the gender variable.

Work experience, either through direct employment, internships, or involvement in entrepreneurship, appears to be crucial for the financial literacy of European university students. This hands-on business experience helps them to acquire new knowledge and skills applying them in practice. While Sugeng and Suryani (2020) emphasize the importance of in-class problem-based learning for subjects related to financial management, we stress the relevance of practice-based learning for consolidating finance management-related skills. This idea aligns with other studies that highlight that financial education impacts directly financial knowledge but not always financial behaviour of university students (Johan et al., 2021) and that work experience enhances students' financial management skills (Nano & Mema, 2017). In addition, it is important to note that previous studies relate internships to larger entrepreneurship since these experiences inspire students to start their businesses (Weible, 2009) and to higher employment rates and financial stability because they start earning income (Kapareliotis et al., 2019; Nunley et al., 2016).

Studies on financial literacy among university students have also been conducted outside Europe. In Pakistan, an analysis of university students enrolled in non-business or non-commerce programmes revealed an average level of financial knowledge. However, the study highlighted a strong and positive influence of factors such as family recommendations, high household income, enrolment in finance-related courses, and prior banking experience (Liaqat et al., 2021). In the United Arab Emirates, research on the multidimensional aspects of financial literacy among university students yielded similar findings. It further identified disadvantaged groups, including women, students who had not completed their undergraduate studies, and those enrolled in non-scientific fields (Douissa, 2020).

A study by Vaghela et al. (2023) on Indian university students extended beyond merely assessing financial knowledge. It explored the interrelationships between financial knowledge, attitudes, and behaviour, revealing a direct and significant connection among these three dimensions. Similar investigations have used samples of university students in the United States (Hanson, 2022), as well as in Mexico and Colombia (Ramos-Hernández et al., 2020), in an attempt to find what factors impact mostly the level of financial knowledge of students. Additionally, Faulkner (2016) reflects on the state of financial education in the United States, advocating for the inclusion of targeted financial literature in educational programming by librarians.

Conclusions

Through the empirical study presented here, the authors try to determine the likelihood that factors such as age, gender, country of study, educational background, and entrepreneurial experience are related to enhancing the basic capabilities that denote higher levels of financial literacy as perceived by European university students. The sample comes from several universities located in Spain, Romania, and Poland and includes 881 undergraduate and postgraduate students from different academic programmes.

Based on the literature review, the authors proposed six hypotheses that suggest the likelihood of high financial literacy among university students depending on the age, gender, country of study, specific education, and work and entrepreneurial experience.

The applied methodology for analysing the data obtained through an anonymous survey is based on cumulative regression models, optimised with a location-scale test because of the high heterogeneity observed in the characteristics of the sampled participants. The analysis is done through four estimations which help to determine a strong relationship between the independent variables and personal financial management measured through the perception of university students of their level of four basic skills related to financial management. The statistical analysis was done using the free software R, version 4.3.2.

The main findings show several determinants that in one way or another shape the financial literacy of university students. First, age is an important factor that increases the probability of having good skills related to personal financial management, in the broad sense of the term. Secondly, it is gender, showing that female participants, generally, are the most skilled in this respect. Thirdly, the country where students study is also related to the development of financial literacy, with Poland having the highest development and Spain the lowest among the three European countries taken in this study. Fourthly, specific training in financial management, especially, short-term courses, is directly related to the level of capability of managing personal finance. Fifth and finally, the authors highlight work (employment contract or internship) as well as entrepreneurial experience as factors that are positively related to the personal financial management skills of university students. Interestingly, the type of general studies, such as Economics, Business Administration, Engineering, Health or Law, just to give a few examples, are not at all related to the ability to manage personal finances.

These results are similar in all four estimations, with the exception that in the fourth estimation, focused on the ability of students to differentiate among non-traditional sources of financing, female participants are shown to be the least skilled, while postgraduate students as the most prepared and somewhat knowledgeable about non-traditional sources of finance. The findings support the proposed hypotheses, except for hypothesis 3, which suggested that there were no significant differences between the abilities of students from different countries.

Having shown that our results are consistent with the extant literature, this study underscores the critical role of practical experience and targeted financial education in enhancing financial literacy among university students, highlighting the need for tailored educational programmes to address the diverse needs of different student groups. In addition, current teaching methods and tools can actively use advanced technology or artificial intelligence that could be of great help for students to put theoretical knowledge into practice through quasi-real scenarios, which would surely help them to build a positive financial attitude, prepare them to make informed financial decisions, and prevent their financial exclusion in an increasingly complex and changing world.

The results presented here have important implications for educational policy. Given the social and economic costs associated with poor financial literacy (over-indebtedness, poor saving behaviour, and limited access to financial products), higher education institutions should strongly consider integrating structured and tailored financial education modules into their curricula. This highlights the value of experiential learning in bridging the gap between theoretical knowledge and real-world financial decision-making, and therefore engaging students with practical simulations and real-world case studies into financial education can significantly enhance its effectiveness and relevance for students across disciplines.

Nevertheless, this study is not without limitations. The data is based on students' self-perceptions of their financial skills, with the possibility of response bias. Future studies could complement this approach with objective assessments or longitudinal tracking of financial behaviours. Additionally, while the study covers three European countries, the findings should not be generalised to other national contexts, particularly to countries such as France, Germany, Sweden or the United Kingdom, as these countries differ significantly in terms of socio-economic development, financial education frameworks, and cultural attitudes towards money. Additional comparative research would be needed to explore whether the determinants identi-

fied here can be applied similarly across Europe or other regions.

Finally, given that one of the findings of this empirical study indicates that complementary education in entrepreneurship and business management, rather than in finance, has a significant influence on students' financial management skills, further research in this area is warranted.

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The appendices are available in the online version of the journal.

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Łukasz Gibowski

Assessment of the Conditions for the Development of the Financial Technology (FinTech) Sector in Selected Countries in 2021

Abstract

The consequences of the 2007–2009 crisis, the dynamic process of digitalisation of economies, and the increased access to the Internet (especially broadband) contributed to the development of innovative technologies in the financial services sector, referred to as the financial technology (FinTech) sector. The development of the FinTech industry is not possible without active support from the state, appropriate legal regulations, innovation, and society's readiness for new financial solutions. The aim of this article is to assess the conditions for the development of the FinTech sector in European Union countries and in major global economies. Using the taxonomic measure of economic development developed by Professor Hellwig, a ranking was constructed that shows that in 2021 the level of the analysed conditions in EU countries and in the largest global economies outside the Community was highly diverse. At the top of the ranking is the United States, which scored over eighteen times higher than the country closing the ranking (India). Poland ranked 26th (out of 34), and thus was classified as a country with conditions that are not very favourable for FinTech operation and development.

Keywords: financial services, innovation, financial technologies, taxonomic analysis, FinTech sector

Introduction

The process of integrating the financial sector with the modern technology industry, observed since the early 1970s, has contributed to the emergence of entities offering FinTech solutions. Nowadays, the efficient functioning of modern economies cannot be imagined without these entities, most commonly referred to in the subject literature as *FinTech* companies. The global leaders in the FinTech sector include companies such as Visa and Mastercard, which develop tools enabling cashless payments.

Along with dynamic growth, the FinTech sector has gradually expanded its activity to include new segments. FinTech companies now offer financial services in areas such as asset management, insurance, financing, and payments. Their presence in these industries significantly increases the scale of operations performed, although the scope and degree of implementation of innovative financial technologies vary between countries. This depends on many conditions, such as the nature of the regulatory and legal environment for FinTech entities, the willingness of society to use financial technologies, and the level of innovation and economic development of a given country. The development of the FinTech sector is so important for improving the quality of service in the financial market and increasing the number of transactions concluded on it that research is being conducted on the level of openness of individual economies to this sector. However, the diversity and complexity of the factors influencing its development give rise to problems in selecting a research method that enables an objective assessment of the analysed issue.

The aim of the article is to assess the conditions for the development of the FinTech sector in selected countries in 2021 using the taxonomic development measure developed by Professor Hellwig, which can be used to create country rankings. The

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analysis covered the 27 European Union countries as well as the United States, the United Kingdom, India, Canada, China, Japan, and Brazil. The high level of innovation in financial technologies enabled the following research hypothesis to be formulated: The best conditions for the development of the FinTech sector have been established in innovative and highly economically developed countries.

The Concept of FinTech

Financial technologies constitute a leading factor in the transformation of the financial sector on a global scale. Although the term *FinTech* has been known since the early 1970s[1], there is still no universal definition of this term.

Currently, there are two fundamental approaches to understanding the essence of FinTech. In the first, FinTech is a form of modern digital technologies that replace, complement, or enhance existing financial services. In the second, it is a term referring to a new industry of non-traditional and innovative financial entities (Giglio, 2022; Harasim & Mitręga-Niestrój, 2018; Suryono et al., 2020). A current review of the literature on how the term *FinTech* is understood is presented in table 1.

As noted by Harasim and Mitręga-Niestrój (2018), when defining the term, some FinTech researchers omit one of its most important aspects, namely, the functional aspect, which is the effects of FinTech. These include reduced costs and greater efficiency of service in the financial sector. Most researchers, however, agree on the high level of innovativeness/modernity of the FinTech phenomenon (Harasim & Mitręga-Niestrój, 2018; Schueffel, 2016).

Harasim and Mitręga-Niestrój (2018) interpret the FinTech phenomenon from both a broad and narrow perspective. According to the broad view, *FinTech* refers to any application of technology that improves the provision of existing financial services and/or creates new types of services. The narrow perspective, on the other hand, defines *FinTech* as an innovative financial services sector comprising non-traditional market participants who use modern technologies—mainly in the process of creating products and services for the banking sector. Thus there is a clear distinction between traditional and innovative financial service providers (Harasim & Mitręga-Niestrój, 2018).

For the purpose of this study, the premises derived from the narrow definition of *FinTech* were adopted. This approach is also used by international institutions studying the financial technology sector, such as the

Table 1
Summary of the Literature Review on Defining the Term FinTech

Approach	Authors	Interpretation of the term FinTech
Object-based	C. C. Vergara and L. F. Agudo	Modern technologies and digital innovations that serve to improve and automate the process of providing financial services to individuals and businesses (Vergara & Agudo, 2021).
	L. A. Abdillah	Any information technology in the financial services industry (Abdillah, 2019).
	S. K. Pant	Innovative technologies used to improve the process of providing financial services (Pant, 2020).
	M. Anshari, M. N. Almunawar, M. Masri and M. Hamdan	Technologies used to provide financial services and products which, compared to those traditionally offered by the banking sector, are more user-friendly and convenient financial management tools for users (Anshari et al., 2019).
Subject-based	Y. Kim, Y.-J. Park, J. Choi and J. Yeon	A service sector that creates and uses modern technologies focused on mobile devices to improve the efficiency of the financial sector (Kim et al., 2016).
	W. Szpringer	Technological entities representing a specific form of shadow banking, which Szpringer (2017) defines as part of the parallel banking system offering financial intermediation services that are not subject to regulation or supervision.
	P. Łasak	Companies that, by combining financial services with modern technologies, contribute to the development of new business models, applications, processes, or products (Łasak, 2021).
	G. B. Navaretti, G. Calzolari and A. F. Pozzolo	Entities providing the same type of financial services as banks, but in a more efficient way due to the use of innovative technologies (Navaretti et al., 2017).

Source: author's own work based on the sources listed with each definition.

[1] The precursor in the use of the acronym FinTech was the Vice President of the New York bank 'Manufacturers Hanover Trust', Bettinger, who, in the early 1970s, used it to describe the fusion of three elements: banking expertise, innovative management methods, and computers (Bettinger, 1972).

educational platform Centre for Finance, Technology and Entrepreneurship (CFTE).

A review of the literature reveals that the FinTech sector is commonly considered to have developed in three stages, which differ fundamentally in terms of access to financial services (Abdillah, 2019; Folwarski, 2019; Leong & Sung, 2018; Pant, 2020). A brief overview of these periods is presented in table 2.

Today, FinTech can be assumed to be in the next stage of development, characterised by close cooperation between the financial technology sector and banks. The banking sector has become the main recipient of these solutions. This cooperation takes various forms, from alliances and mergers between entities to financial and substantive support provided to FinTech companies by banks through incubation and acceleration programmes or Venture Capital funds. Banks also establish their own FinTech companies.

The FinTech sector should be perceived as a complex and heterogeneous system composed of numerous segments and subsegments. In particular, the following segments can be identified: (1) financing; (2) asset management; and (3) payments.

Three basic subsegments make up the financing segment: those based on crowdfunding, those providing credit services, and those operating in the field of factoring (Anshari et al., 2019; Folwarski, 2019; Giglio, 2022; Kmita, 2020). Brunello (2015/2016) perceives *crowdfunding* as a process of cooperation among a group of individuals willing to allocate private financial resources, via specialised online platforms, in order to support the implementation of projects. The term in question, a neologism combining the words *crowd* and *funding*, is associated with projects of virtually any kind – from charitable initiatives to business ventures (Brunello, 2015/2016).

Demographic processes and changes in consumer preferences and approaches to investment strategies have contributed to the emergence of a segment within the FinTech sector that operates in the area of asset management. This gave rise to the automation of financial services, leading to phenomena such as robo-advisory and social trading (Giglio, 2022). Investors using social trading present and exchange trading ideas and investment strategies. In doing so, they observe the results achieved by other entities perceived as experts (Leong & Sung, 2018; Ziobrowska, 2021). In the subsegment related to automation, entities implement systems based on special algorithms, enabling, among other things, investment portfolio management (Kmita, 2020).

Companies forming the payments segment offer services related to the execution of domestic and international payment transactions. FinTech entities operating in this segment work using blockchain technology solutions, cryptocurrencies, and alternative payment methods (CFTE, 2022; Kmita, 2020).

With the dynamic evolution of the financial technology industry, FinTechs have gradually expanded their operations to new markets, including the insurance market. Entities operating in this field, referred to as *InsurTechs*, work on innovative insurance solutions. This term, similarly to FinTech, is an acronym of the words *insurance* and *technology* (Kmita, 2020).

In order to streamline the process of bringing innovative financial technologies to market, most national supervisory authorities provide various forms of support to FinTech companies. These include regulatory sandboxes and innovation hubs. The former allow companies, usually start-ups, to test their innovative financial solutions. An innovation hub, in turn, should be viewed as a dedicated contact centre, facilitating

Table 2

Stages of Development of the FinTech Sector

Period	Stage name	Description
1866–1966	FinTech 1.0	The beginning of FinTech is marked by the establishment of the first transatlantic telegraph cable connection between Europe and North America. FinTech 1.0 was based on the development of infrastructure enabling global communication among the media, individuals, governments, organisations, and financial markets. However, it primarily concerned developed countries such as the USA, France, and the United Kingdom (Pant, 2020).
1967–2008	FinTech 2.0	Pant (2020) identifies the activation of an ATM at a Barclays Bank branch in London as the beginning of FinTech 2.0. The years 1967–2008 marked a period of digitalisation, technological advancement, and the evolution of payment systems. In 1971, the first electronic exchange, NASDAQ, was established—an important step in the digitalisation of financial markets. The early 1980s saw developed countries' banks shift from manual systems to computerised ones. Unlike FinTech 1.0, FinTech 2.0 extended its scope globally across various sectors. By the end of this stage, the development of internet-based business had begun (Abdillah, 2019; Leong & Sung, 2018).
2009–present	FinTech 3.0/3.5	Following the 2007–2009 financial crisis and the intensification of financialisation, a phase of rapid development in the innovative financial services sector began. Since the outset of the FinTech 3.0 era—initiated in developed countries and evolving into the FinTech 3.5 era as it expanded to developing countries—the financial technology startup industry has experienced dynamic growth. These entities, though not strictly traditional banking institutions, began offering financial and banking products and services (Folwarski, 2019; Pant, 2020).

Source: author's own work based on the sources cited in the descriptions of individual stages.

the exchange of opinions and experiences between FinTech entities (Alińska, 2019).

RegTech subsector (an acronym of *regulatory technology*) entities also contribute to the more efficient functioning of the FinTech sector. Using modern technologies, these entities deal with resolving contentious issues relating to regulatory and supervisory requirements. There are two types of *RegTech* entities: companies offering their services to supervisors, financial institutions and regulators, and entities that support only supervisors and regulators (Folwarski, 2019).

Research Methodology

As mentioned above, the development of the FinTech sector has been the subject of numerous academic studies conducted by both Polish and foreign scholars. As a result of their work, indices have been developed that measure the openness of particular economies to financial innovations. In constructing these indices, authors have employed a variety of research methodologies and sets of variables. For instance, when constructing a FinTech index for the European Union countries, Folwarski (2019) adopted six variables, including the number of FinTech companies and a binary variable indicating the existence (or non-existence) of an innovation hub[2] in a given country. To determine the index value, he used decile-based classification (Folwarski, 2019).

Due to the complexity and dynamic growth of the financial technology sector, it is not possible to develop a universal indicator for assessing the conditions for the operation of the FinTech industry. In this study, a measure was selected that accounts for the multidimensional nature of FinTech and enables a hierarchy of countries to be constructed.

The proposed measure is the taxonomic measure of development created by Professor Hellwig[3] (1968), which enables quantification of the level of the studied conditions by means of a single value. This measure can be used to examine economic, social, environmental, and cultural phenomena at various levels of analysis (from local to global). As a linear ordering method, it allows the ranking of objects from the highest to the lowest position in the hierarchy. This hierarchy is established based on the value of the taxonomic measure of development (TMR_i). The TMR_i is constructed to enable a holistic approach to the studied issue, serving as a synthetic measure of the variables that characterise it (Hellwig, 1968; Nowak, 1990).

The TMR_i is structured in several stages: (1) selection of diagnostic variables and determination of their character (stimulant, destimulant or nominant); (2) analysis of the variability and mutual correlation of variables; (3) standardisation of variables[4]; (4) determination of the development pattern; (5) determination of Euclidean distances from the adopted development pattern for each examined unit (in this article, for each country studied); (6) calculation of the value of the TMR_i (Hellwig, 1968; Nowak, 1990; Młodak, 2006).

In the study presented, fifteen diagnostic variables were initially proposed to characterise the conditions for the development of the FinTech sector in selected countries in 2021. A detailed description of the variables is presented in table 4 (Appendix). The variables were selected based on their relevance to the phenomenon studied and the quality and availability of data. In addition to substantive and formal criteria, statistical criteria related to variability and correlation of features were also taken into account. All variables used in the study were required to exhibit high variability and low mutual correlation (Kukuła, 2000; Strahl, 2006; Zeliaś, 2002). The proposed variables can essentially be classified into the following groups of factors:

- the proportion of people using selected financial services and the Internet (X_1–X_4, X_{14});
- the level of development of the services sector, including banking activity (X_5–X_7);
- the degree of economic development and innovation of countries (X_9–X_{11}) – as innovative and economically developed countries provide favourable conditions for the creation of new technologies;
- the state of the regulatory and legal environment for the FinTech sector (X_{12});
- the development of FinTech companies (X_8 and X_{13});
- the level of cybersecurity (X_{15}) – this is a particularly important aspect in the context of risks related to data theft from institutions using financial technologies.

From the initially proposed set of variables, those with low variability (i.e., variables for which the coefficient of variation was below ten percent) and those showing a strong correlation (i.e., for which

[2] In this study, the two variables indicated by Folwarski (2019) were also adopted, although the number of FinTech companies was given per 500,000 inhabitants – X8. The aforementioned binary variable, on the other hand, is included as variable X12.

[3] The development of quantitative taxonomy was initiated in the early 20th century by Czekanowski. However, the pioneer in applying the linear ordering method within taxonomy was Hellwig. The measure of economic development he introduced in 1968 enables the linear ranking of objects using the so-called *development pattern* (Hellwig, 1968; Walesiak, 2016). Taxonomic methods for constructing synthetic variables for econometric modelling processes were introduced by Bartosiewicz (1984).

[4] This enables the transformation of variables to a common scale. This minimises the impact of differing units of measurement and value ranges of individual characteristics on the final value of the indicator (Młodak, 2006; Nowak, 1990).

the absolute value of Pearson's correlation coefficient exceeded 0.7)[5], were eliminated. Ultimately, four features were rejected (X_1, X_2, X_5, and X_{10}).

In order to standardise the heterogeneous data into comparable values, the features were normalised by standardisation according to formula 1 (Hellwig, 1968; Młodak, 2006; Nowak, 1990):

$$Z_{ik}=\frac{x_{ik}-\overline{x}_k}{S_k} \quad \text{for } (i=1,2,\ldots,n;\ k=1,2,\ldots,m) \qquad (1)$$

where:
Z_{ik} – standardised value of feature k in unit i;
x_{ik} – absolute value of feature k in unit i;
$\overline{x}_k$ – arithmetic mean of feature k;
S_k – standard deviation of feature k;
n – number of countries;
m – number of variables.

As a result, a matrix of standardised variable values Z was obtained:

$$Z=\begin{bmatrix} z_{11} & z_{12} & \ldots z_{1k} \\ z_{21} & z_{22} & \ldots z_{2k} \\ \ldots & \ldots & \ldots \ldots \\ z_{i1} & z_{i2} & \ldots z_{ik} \end{bmatrix} \qquad (2)$$

Based on the […], a development pattern was determined, representing an abstract object (country) P_0 with the most favourable values of the diagnostic variables describing the studied phenomenon (Hellwig, 1968):

$$P_0=[z_{01}, z_{02}, \ldots, z_{0k}] \qquad (3)$$

where:
$z_{0k} = \max\{z_{ik}\}$ for stimulants,
$z_{0k} = \min\{z_{ik}\}$ for destimulants.

In the next step, for each of the studied entities (countries), the Euclidean distances (d_{i0}) from the development pattern were calculated using formula (4) (Hellwig, 1968; Nowak, 1990):

$$d_{i0}=\sqrt{\sum_{k=1}^{m}(z_{ik}-z_{0k})^2} \qquad (4)$$

Ultimately, the taxonomic development measure TMR_i was determined using formula (5) (Hellwig, 1968):

$$TMR_i = 1-\frac{d_{i0}}{c_0} \quad \text{for } (i=1,2,\ldots,n) \qquad (5)$$

where:

$$\overline{c}_0 = c_0 + 2\cdot S_0 \qquad (7)$$

$$\overline{c}_0 = \frac{1}{n}\cdot\sum_{i=1}^{n} d_{i0} \qquad (8)$$

$$S_0=\sqrt{\frac{1}{n}\cdot\sum_{i=1}^{n}(d_{i0}-\overline{c}_0)^2} \qquad (9)$$

The TMR_i usually takes values in the range [0, 1][6] (Hellwig, 1968). The closer its value is to 1, the closer a given country is to the pattern and the more favourable are its conditions for the development of the FinTech sector. Additionally, using the arithmetic mean value ($\overline{TMR_i}$) and the standard deviation (S_{TMR_i}) of the TMR_i, each country was assigned to one of the following groups (Stec, 2015; Zeliaś, 2002):

- I – countries with very favourable conditions for the development of the FinTech sector ($TMR_i \geq \overline{TMR_i} + S_{TMR_i}$)[7];
- II – countries with highly favourable conditions for the development of the FinTech sector ($\overline{TMR_i} \leq TMR_i < \overline{TMR_i} + S_{TMR_i}$);
- III – countries with somewhat favourable conditions for the development of the FinTech sector ($\overline{TMR_i} - S_{TMR_i} \leq TMR_i < \overline{TMR_i}$);
- IV – countries with the least favourable conditions for the development of the FinTech sector ($TMR_i < \overline{TMR_i} - S_{TMR_i}$).

The value of the taxonomic development measure was determined for 34 countries. These included all European Union Member States and other major world economies. This selection was based on several important premises. Firstly, the selected countries have stable financial systems and play a key role in the international financial sector. Secondly, their diversity in terms of economic, social, and regulatory-legal conditions enables examination of the factors determining the development of favourable conditions for the FinTech sector. Additionally, the availability of high-quality statistical data for the selected countries facilitates the conduct of research related to the FinTech sector.

Research Results

The results of the conducted analysis are presented in table 3 and illustrated in figure 1. The calculations were performed using Microsoft Excel.

[5] The threshold value of the coefficient of variation is most commonly assumed to be ten percent (Młodak, 2006; Olszewska, 2014). When determining the critical value of Pearson's linear correlation coefficient, reference was made to the premises adopted in other studies concerning various socio-economic phenomena in which the Hellwig method and the indicated correlation measure were applied (Kiczek, 2015; Miłek & Mistachowicz, 2019; Olszewska, 2014; Stec, 2015).

[6] Its upper limit is 1. The probability that its value will be less than 0 is low (Hellwig, 1968).

[7] $\overline{TMR_i}$ is approx 0.226; while S_{TMR_i} is 0,113.

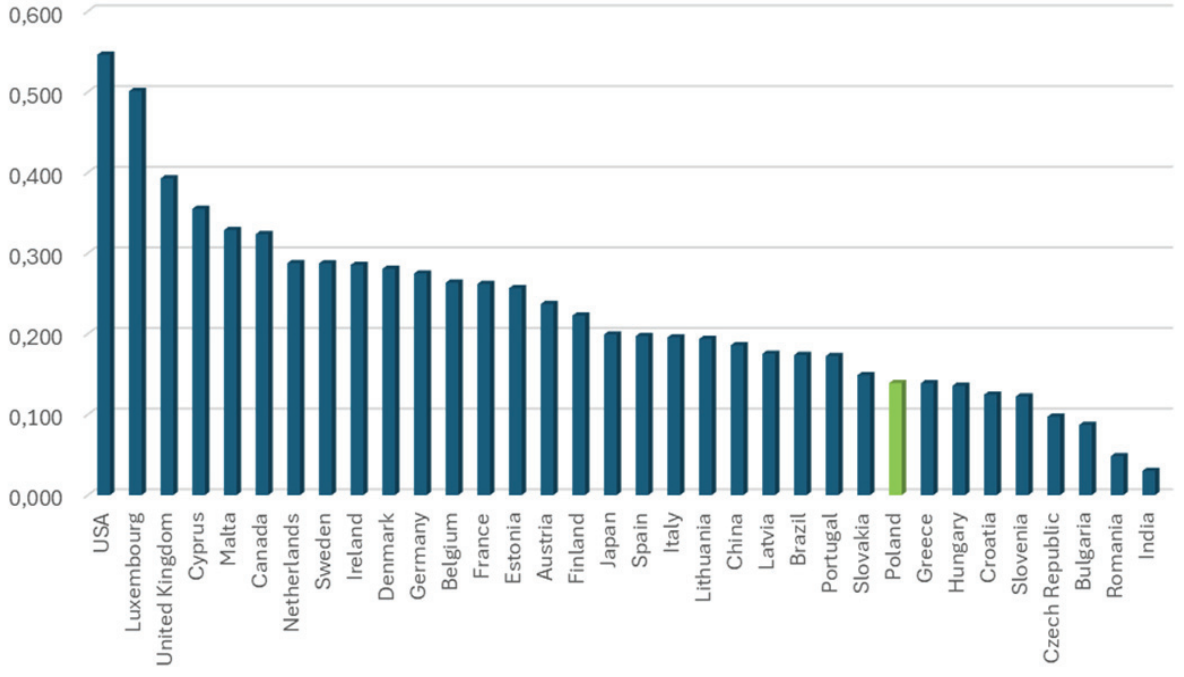
Table 3
Classification of the Examined Countries According to the Constructed Measure of FinTech Sector Development Conditions

Group	Ranking	Country	TMR_i value
Group I ($TMR_i \geq 0.338$)	1	USA	0.546
	2	Luxembourg	0.501
	3	United Kingdom	0.393
	4	Cyprus	0.355
Group II ($0.226 \leq TMR_i < 0.338$)	5	Malta	0.329
	6	Canada	0.324
	7	Netherlands	0.288
	8	Sweden	0.287
	9	Ireland	0.285
	10	Denmark	0.281
	11	Germany	0.275
	12	Belgium	0.263
	13	France	0.262
	14	Estonia	0.257
	15	Austria	0.237
Group III ($0.113 \leq TMR_i < 0.226$)	16	Finland	0.223
	17	Japan	0.199
	18	Spain	0.197
	19	Italy	0.196
	20	Lithuania	0.194
	21	China	0.186
	22	Latvia	0.175
	23	Brazil	0.174
	24	Portugal	0.172
	25	Slovakia	0.149
	26	**Poland**	**0.1389**
	27	Greece	0.1386
	28	Hungary	0.136
	29	Croatia	0.125
	30	Slovenia	0.122
Group IV ($TMR_i < 0.113$)	31	Czech Republic	0.097
	32	Bulgaria	0.087
	33	Romania	0.048
	34	India	0.030

Source: author's own work.

The study results showed that in 2021 the United States was the most favourable country for the operation and further development of the FinTech sector (0.546 points). The next positions in the ranking were taken by Luxembourg, the United Kingdom, and Cyprus. The high ranking of these leaders was determined, among other things, by the high percentage of people holding an account with a financial institution or a mobile financial services provider. This indicates a strong inclination of residents of these countries to use financial services, which generates demand for FinTech solutions. Countries in Group I also had the highest share of exports of financial and insurance services in total commercial service exports. In each of these countries, FinTech companies had broad access to tools facilitating compliance with regulatory and le-

Figure 1
TMR_i Index Values for Selected Countries in 2021



Source: author's own work.

gal obligations for their operations. Furthermore, the United States and the United Kingdom were awarded very high values in innovation and cybersecurity indices. This means that they provided friendly and secure conditions for the development of innovative financial technologies. In Luxembourg and Cyprus, alongside Estonia and Malta, the highest number of FinTech companies per 500,000 inhabitants was recorded in 2021. However, the United States and the United Kingdom hosted the highest number of major FinTech players globally, with 46 and 7 companies respectively, according to the CFTE.

Among the least FinTech-friendly countries in 2021 were, from the lowest position: India, Romania, Bulgaria, and the Czech Republic, with India's TMR_i score being 0.067 points lower than that of the Czech Republic. India's poor result was driven in part by the highest percentage of people with inactive bank accounts and the lowest value added in the services sector (as a percentage of GDP) among all the surveyed countries. In 2021, India also had a significantly lower GDP per capita compared to the remaining countries. Moreover, India and Romania were among the least innovative economies. In India, Romania, and Bulgaria, the lowest percentage of people with an account at a financial institution or mobile provider was recorded, which may indicate a low willingness of citizens to use financial services and/or barriers in access to them. Notably, despite these unfavourable conditions, several global FinTech companies have emerged in India (e.g. the financial platform Razorpay).

Poland, with a TMR_i score of 0.139 points, ranked 26th in the table, placing it among fourteen other countries where the conditions for FinTech sector development were classified as unfavourable. In Poland, the number of FinTech companies per 500,000 inhabitants was relatively low (tenth from the bottom). Moreover, none of the FinTech companies was included in the list of the top one hundred FinTech companies globally. The development of the FinTech sector in Poland was also hindered by the relatively low level of economic development and innovativeness (seventh place from the bottom for development and sixth place from the bottom for innovativeness).

Summary

The development of financial technologies is introducing a new quality in the provision of financial services. The phenomenon under study has spread across the global financial system, yet the level of FinTech sector development varies significantly between countries. This variation is due to numerous factors. The taxonomic measure of development (TMR_i) constructed in this study, which takes into account various aspects that promote or hinder the development of financial technologies, made it possible to identify, evaluate, and classify the countries analysed in terms of the level of development of the relevant conditions.

The results of the study confirm the research hypothesis. As demonstrated, the level of development

of the conditions under analysis varied significantly among EU Member States and the largest non-EU world economies. The gap between the countries with the highest and the lowest TMR_i scores was 0.516 points. The United States was the most favourable country for the FinTech sector in 2021, while India was the least favourable. The United States is an innovative and economically developed country with a strong capacity for cybersecurity. In contrast, the main barriers to the development of this sector in India were a low percentage of people holding bank accounts, low GDP per capita, and low level of innovativeness. Poland was ranked among the countries with less favourable conditions for the FinTech sector. Among the EU countries, Poland was only ahead of Greece, Hungary, Croatia, Slovenia, the Czech Republic, Bulgaria, and Romania.

The study results indicate that countries classified in Groups III and IV require an in-depth analysis of the current state of the financial technology sector. This analysis should serve to devise an effective strategy for measures to support the development of the FinTech sector. Estonia may be considered a model for effectively creating favourable conditions for the sector's development. Despite having a much lower level of economic development than countries such as Germany, Sweden, Denmark, and France, Estonia ranked among the countries with highly favourable conditions for the development of the FinTech sector. This is because Estonia follows a pro-innovation approach to developing modern technologies. The Estonian government has created simple and transparent legal regulations, thereby facilitating the establishment and operation of businesses in the financial technology sector. In addition, the development of the FinTech sector in Estonia is supported by a high level of digitalisation of society and the widespread use of mobile and internet technologies among its population.

The future development of the FinTech sector in individual countries will be shaped by numerous factors, including the intensity of work undertaken by national regulators in developing solutions for companies creating financial innovations. The state of the industry in question will also be significantly influenced by the level of public trust in newly developed financial technologies, as well as the effectiveness of institutions responsible for ensuring safe conditions in cyberspace. During the course of the study, however, a research gap was identified in terms of precisely determining the impact of FinTech sector development on the security of the financial sector. It would seem appropriate to conduct a study that takes into account the perspectives of both financial institutions and individuals using financial services.

The appendix is available in the online version of the journal.

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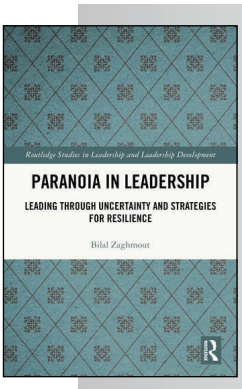

We recommend

Bilal Zaghmout, ***Paranoia in Leadership. Leading Through Uncertainty and Strategies for Resilience***

Leadership has emerged as a cornerstone of progress and transformation in organizations and societies in a world marked by constant change and ambiguity. However, one of the most formidable challenges leaders face is paranoia in leadership. This book is a profound exploration of this enigmatic phenomenon that plagues leaders and organisations, offering insights, solutions, and guidance for those navigating the complex terrain of leadership. With its unique focus on navigating paranoia within the context of leadership, this book delves explicitly into the nuanced challenge of paranoia.

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Leveraging ICT for Knowledge-Driven Agripreneurial Innovations: Advancing Sustainable Development Goals in Rural Economies

Abstract

Bringing innovation to agriculture is essential for the development of rural areas, but such development needs to be environmentally sustainable and grounded in technological advancement. Today, there is a need for innovations based on knowledge in order to ensure sustainable development in the agricultural sector. The present research compares the influence of access to ICT (Information and Communication Technology) infrastructure, knowledge acquisition for sustainable practices, and ICT literacy on the adoption of sustainable agricultural innovation, with data collection conducted through a structured questionnaire using structural equation modelling (SEM) with SmartPLS 4 to meet this objective. The results obtained demonstrate that Access to ICT Infrastructure, Knowledge acquisition for sustainable practices, and ICT Literacy have a significant impact on the adoption of sustainable agricultural innovation, with knowledge acquisition for sustainable practices showing the most critical impact, followed by access to ICT infrastructure and ICT literacy.

Keywords: green innovation, green entrepreneurship, sustainable farming, digitalisation, technology

Introduction

High-tech upgradation in agricultural accomplishments is essential for the expansion of rural economies (Kroupová et al., 2025). For the advancement of agriculturalists, it's vital to foster an environment grounded in suitable knowledge attainment that can ensure the longevity of their methods (Zossou et al., 2020), which is only possible if innovation is encouraged in the working style of the farming sector of the economy (Onegina et al., 2025). The promotion of Information and Communication Technology can be significantly helpful in promoting digitalisation amongst farmers (Paul & Jena, 2024). ICT is pivotal, as there is currently no viable substitute for digitalisation in achieving success (Chandio et al., 2024), and it is essential to establish a connection between every success and sustainable development to prevent progress at the expense of the environment (Requelme & Afonso, 2023).

The current study examines the impact of "access to ICT infrastructure, "knowledge acquisition for sustainable practices", and "ICT literacy" on "sustainable agricultural innovation adoption." The findings obtained through a methodical evaluation will be useful in reducing the digital gap and encouraging legislators to advance procedures related to sustainable farming with ICT.

Understanding the context in which terms are used in the present research is significant for grasping the essence of the results obtained. Table 1 presents a conceptual understanding of the variables, supporting clearer comprehension of the subsequent sections of research.

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Table 1
Important Definitions

Sr. No.	Terms	Detailed definitions
1	ICT	ICT, or Information and Communication Technology, epitomises the convergence of computational paradigms and telecommunication modalities to enable ubiquitous information synthesis, dissemination, and retrieval (Wang et al., 2025).
2	Agripreneurial innovations	Agripreneurial innovations embody the sophisticated confluence of transformative agronomic methodologies, disruptive entrepreneurial paradigms, and cutting-edge technological advancements, strategically orchestrated to revolutionise traditional agricultural ecosystems, optimise resource utilisation, enhance value-chain dynamics, and foster sustainable socio-economic development in an increasingly complex global agri-food landscape (Long et al., 2019).
3	ICT infrastructure	ICT infrastructure constitutes the intricate ensemble of advanced computational hardware, sophisticated software architectures, high-capacity telecommunication frameworks, and interoperable digital networks, meticulously engineered to enable the seamless transmission, storage and processing of data, thereby underpinning the technological scaffolding essential for pervasive connectivity, cyber-physical integration, and the propagation of information in an increasingly digitised and hyperconnected global ecosystem (Bibi et al., 2024).
4	ICT literacy	ICT literacy represents the comprehensive aptitude to proficiently navigate, critically evaluate (Eisenberg et al., 2016), and innovatively utilise an intricate array of digital technologies, computational tools, and telecommunication systems, encompassing advanced cognitive skills and nuanced technical proficiencies essential for effective engagement, adaptive problem-solving, and informed decision-making within an exponentially evolving, information-saturated digital paradigm (Adeyoyin, 2005).
5	Knowledge acquisition for sustainable practices	Knowledge acquisition for sustainable practices encompasses the intricate process of systematically assimilating, critically analysing, and innovatively applying multidisciplinary insights, empirical evidence, and contextualised expertise to devise and implement ecologically resilient, economically viable, and socially equitable strategies that harmonise anthropogenic activities with the imperatives of environmental stewardship and intergenerational equity within a dynamically evolving global sustainability framework (Chen et al., 2020).
6	Sustainable agripreneurial innovation adoption	Sustainable agripreneurial innovation adoption embodies the multifaceted process of integrating avant-garde agricultural methodologies, eco-centric entrepreneurial ventures, and disruptive technological paradigms, meticulously calibrated to optimise resource efficiency, bolster environmental resilience, and foster socio-economic inclusivity while navigating complex systemic interdependencies to achieve scalable, enduring and transformative impacts within the global agri-food ecosystem (Elzen et al., 2011).
7	Agripreneur	A farmer who adopts business principles in farming (Kasim & Salleh, 2023).
8	Agribusiness innovation	New methods or technologies enhancing agricultural productivity (Wei & Sutunyarak, 2025).
9	Sustainable farming practices	Eco-friendly methods ensuring long-term agricultural viability (Byfuglien et al., 2025).

Source: authors' own work based on the sources listed with each definition.

This study is structured into six main sections. Following the introduction, a literature review is presented, leading into the research methodology and Data Analysis. The findings are then discussed in comparison with previous studies. The paper concludes with a summary in the final section.

Need for Study

The study is imperative to address the critical need for empirical insights into how access to ICT infrastructure, ICT literacy, and Knowledge acquisition synergistically drive sustainable agripreneurial innovation adoption, thereby catalysing rural socio-economic transformation and advancing Sustainable Development Goals in under-resourced regions.

The present study will also help create a framework for the development of an agrarian class of the economy. Agricultural development plays a significant role in the development of the entire economy, as the primary sector is the base for the development of the secondary and tertiary sectors. It is therefore essential to stress the need to bring innovations in the farming sector that further support sustainable development.

Research Gap

Despite the increasing global emphasis on leveraging ICT for sustainable development, a significant research gap persists in comprehensively examining how ICT infrastructure accessibility (Hasan et al., 2023) and ICT literacy together influence both knowledge acquisition and the adoption of sustainable agribusiness innovations-particularly within the nuanced socio-economic and environmental contexts of rural economies (Banhazi et al., 2012).

Literature Review

Literature review in research is significant to have an assessment of available texts that serve as the basis for the identification of necessary variables that form part of the conceptual model in the present research. The Literature review section in this paper is divided into three parts:

- background of the study
- theoretical framework
- related studies.

Background of the Study

The study emanates from the pressing imperative to address systemic inefficiencies, structural inequities, and resource paucity within rural economies by exploring how the transformative nexus of Information and Communication Technology (ICT) and agripreneurial innovation can be harnessed within knowledge-driven ecosystems, expanding digital infrastructure, and adaptive capacity-building. Together, these dynamics aim to recalibrate socio-economic frameworks, fortify ecological resilience, and accelerate the realisation of Sustainable Development Goals (SDGs) amidst the complex challenges posed by globalisation, climate volatility, and demographic transitions.

Theoretical Framework

Theories are the foundation of a research paper's structure. The conceptual model (Figure 2) of the present research is based on the integration of five theories, as shown in Table 2. By borrowing the principles of these theories, the present research attempts to explore the Adoption of Innovation in Sustainable Agriculture.

Behind levying pertinent theories, it is also essential to scan related studies of present research. The subsequent division furnishes an exhaustive discussion of the hypothesis and ex-literature connected to it, recreating a paramount position in approximating recent developments with earlier consequences, in order to devise a research framework for prospective examinations.

Related Studies

The present research contains five hypotheses, shown in Table 3, each assuming a relationship between two variables, which will be tested by running Bootstrapping in the Data Analysis section of the Present research. Table 3 also contains several studies supporting the reasoning behind framing a specific hypothesis.

Table 2
Theoretical Framework

Name of theory	Description of theory	Relation and relevance of theory with current study
Diffusion of Innovations Theory	This theory elucidates how innovations are communicated (Moore, 1991) and adopted within social systems over time, emphasising the role of knowledge dissemination, social networks and perceived utility in influencing adoption trajectories across diverse adopter categories (Adams, 1997; Marshall, 1990).	The model reinforces the study's assertiveness on how access to ICT literacy facilitates knowledge acquisition and the adoption of sustainable agribusiness modernisation, arranging these consequences as key to achieving sustainable rural development.
Technology Acceptance Model (TAM)	This template investigates elements of technology acceptance, focusing on perceived usefulness and ease of use as pivotal factors influencing behavioural intentions and the actual adoption of technologies.	TAM is integral to understanding how ICT literacy influences the ease and perceived utility of ICT tools for knowledge acquisition and innovation adoption, thereby advancing sustainable agripreneurial practices in rural contexts.
Sustainable Livelihoods Framework	This framework highlights the interconnections between human, social and physical capital in enhancing resilience and fostering socio-economic sustainability in resource-constrained environments (Hinshelwood, 2003).	The framework aligns with the study by emphasising how access to ICT infrastructure and literacy empowers rural communities to acquire knowledge and adopt innovations, ultimately enhancing sustainable agripreneurial practices and socio-economic resilience.

Source: authors' own work based on the sources listed with each theory.

Table 3
Related Studies

Null Hypothesis	Hypothesis description	Related studies
H1	Access to ICT infrastructure impacts knowledge acquisition for sustainable practices	Access to ICT infrastructure significantly influences knowledge acquisition for sustainable practices by facilitating the dissemination of environmental information, enhancing awareness of sustainability issues, and empowering communities to adopt eco-friendly behaviours through platforms for learning and collaboration, with studies indicating that improved digital accessibility correlates with increased adoption of sustainable agricultural and energy practices (Aseey & Andollo, 2019).
H2	Access to ICT infrastructure affects sustainable agripreneurial innovation adoption	Access to ICT infrastructure plays a pivotal role in fostering sustainable agripreneurial innovation adoption by enabling real-time access to market information, enhancing knowledge exchange on sustainable farming practices and reducing transaction costs, thereby promoting innovation diffusion and entrepreneurial success in agriculture (Ahad et al., 2020; Lin et al., 2017; Monavvarifard et al., 2019; Nakayama et al., 2021).
H3	ICT Literacy impacts knowledge acquisition for sustainable practices	ICT literacy significantly impacts knowledge acquisition for sustainable practices by enabling individuals to efficiently access, interpret and utilise digital resources, enhancing their understanding of environmental issues, fostering awareness of innovative sustainability techniques and empowering them to implement informed decisions and eco-friendly behaviours that contribute to environmental conservation and long-term sustainability, while bridging knowledge gaps and promoting collaboration through digital networks, thereby ensuring equitable and inclusive access to critical information across diverse populations and geographies (Ceballos et al., 2024).
H4	ICT Literacy impacts sustainable agripreneurial innovation adoption	ICT literacy plays a crucial role in sustainable agripreneurial innovation adoption by empowering agripreneurs with the skills to navigate digital platforms, access real-time market information, interpret advanced technological tools. It also allows them to participate in global knowledge-sharing networks, thereby fostering the integration of eco-friendly innovations, enhancing resource efficiency and enabling informed decision-making to address environmental challenges, improve productivity, and promote economic resilience within agricultural systems, while simultaneously reducing barriers to technology adoption and supporting the transition to sustainable agricultural practices across diverse socio-economic contexts (Alant & Bakare, 2021).
H5	Knowledge acquisition for sustainable practices impacts sustainable agripreneurial innovation adoption	Knowledge acquisition for sustainable practices significantly impacts sustainable agripreneurial innovation adoption. It provides agripreneurs with critical insights into eco-friendly techniques, enhancing their ability to incorporate innovative technologies, fostering an understanding of market trends and environmental regulations, and equipping them to overcome operational challenges. It thereby enables the integration of sustainable practices into agripreneurial ventures, improving productivity and resilience, and promoting environmentally conscious entrepreneurship that aligns with long-term sustainability goals across diverse agricultural ecosystems (Duffy et al., 2021; Sadovska et al., 2020).

Source: authors' own work based on the sources listed with each related study.

Research Methodology

Multi-stage sampling was employed to collect responses from the state of Maharashtra, India, to achieve the research objectives. Given its heterogeneous agro-climatic conditions, progressive adoption of agritech innovations, and robust digital infrastructure bolstered by extensive rural connectivity initiatives, Maharashtra emerges as a quintessential locus for examining the intersection of agripreneurial innovation, sustainable resource management, and ICT-driven knowledge dissemination. Multi-stage sampling is a blend of stratified and convenience sampling. In Stratified sampling, groups are made from regions of research on a specific basis, and then data is collected from those groups on a random basis. However, instead of choosing respondents randomly, in the present research data is collected from them on the basis of convenience.

Table 4 contains a demographic breakdown of the respondent's profile, with the sample stratified based on four regions: Pune, Nagpur, Nashik and Aurangabad. These regions are strategically significant due to their distinct agro-ecological zones, substantial smallholder farmer populations, burgeoning agritech hubs, and well-established institutional frameworks that collectively facilitate the gathering of diverse, representative and nuanced data sets essential for comprehensively analysing ICT-enabled agripreneurial innovations. The sample size is 368 respondents, which is appropriate for G*power software as per calculations shown in Figure 1. According to the software, the minimum sample size is 164, so the sample size in this case is more than double the minimum sample size.

The respondents were given the research instrument as in the attached Appendix. The data on this research instrument was collected using the direct personal investigation method, as the farmers from the area needed detailed information regarding the essence of the question. To ensure that the respondents grasped the question appropriately, each question was explained systematically to the respondents before recording their responses.

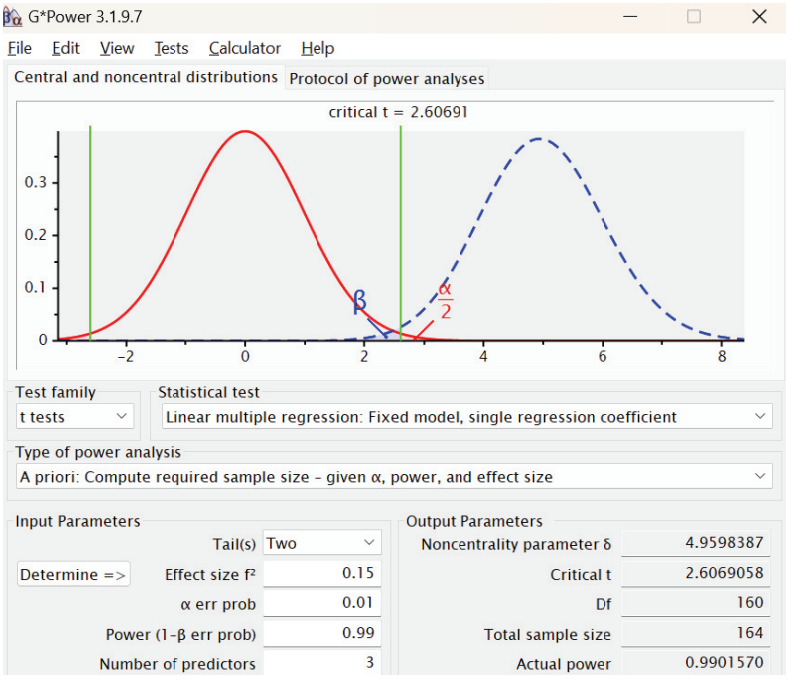
After following the methodology stated in the current section, the next step was to run data in SMART PLS 4 software. The next section shows the results of running data in the required software, which forms the basis for further discussion.

Table 4
Demography of Respondents

Occupational profile	**Frequency**	**Percentage**
Rural farmers	98	26.63%
Agricultural extension workers	82	22.28%
Small-scale agribusiness owners	19	5.16%
Local community leaders	5	1.36%
Agricultural cooperatives members	23	6.25%
Rural youth groups	11	2.99%
Local government officials	35	9.51%
Agricultural consultants	41	11.14%
Academicians	54	14.67%
Total	**368**	**100%**
Gender	**Frequency**	**Percentage**
Male	206	55.98%
Female	162	44.02%
Total	368	100%
Place	**Frequency**	**Percentage**
Pune	94	25.54%
Nagpur	105	28.53%
Nashik	87	23.64%
Aurangabad	82	22.28%
Total	**368**	**100%**

Source: authors' own work.

Figure 1
Minimum Sample Size



Source: authors' own work.

The following processes are applied to obtain the results:

$$\lambda XY = \mathrm{Cov}(X, Y) \,/\, \mathrm{Var}(X) \tag{1}$$

$$r_{xy} = \frac{\Sigma(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\Sigma(x_i - \overline{x})^2 \Sigma(y_i - \overline{y})^2}} \tag{2}$$

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{k} \sigma_{y_i}^2}{\sigma_x^2}\right) \tag{3}$$

$$\frac{\left(\sum_{i=1}^{p} \lambda_i\right)^2}{\left(\sum_{i=1}^{p} \lambda_i\right)^2 + \sum_{i}^{p} \mathrm{V}(\delta)} \tag{4}$$

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n} \tag{5}$$

$$\mathrm{HTMT}_{ij} = \frac{1}{K_i K_j} \sum_{g=1}^{K_i} \sum_{h=1}^{K_j} r_{ig,jh} \div \left(\frac{2}{K_i(K_i-1)} \cdot \sum_{g=1}^{K_i-1} \sum_{h=g+1}^{K_i} r_{ig,ih} \cdot \frac{2}{K_j(K_j-1)} \cdot \sum_{g=1}^{K_j-1} \sum_{h=g+1}^{K_j} r_{jg,jh} \right)^{\frac{1}{2}} \tag{6}$$

$$\overline{X} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{7}$$

$$\sigma = \frac{1}{N} \sqrt{N \sum_{i=1}^{n} f_i x_i^2 - \left(\sum_{i=1}^{n} f_i x_i\right)^2} \tag{8}$$

$$t = \frac{\bar{x}_d - \mu_d}{\left(\frac{s_d}{\sqrt{n}}\right)}, df = n - 1 \tag{9}$$

$$Z = \frac{\hat{p} - p0}{\sqrt{p0(1-p0)}} \tag{10}$$

$$\widehat{\mathrm{se}}_{\mathrm{boot}} = \left\{ \sum_{b=1}^{B} \left[s(\mathbf{x}^{*b}) - s(\cdot) \right]^2 / (B-1) \right\}^{\frac{1}{2}} \tag{11}$$

Data Analysis

Data analysis is a dual stage process in current research:

- PLS Algorithm
- Bootstrapping.

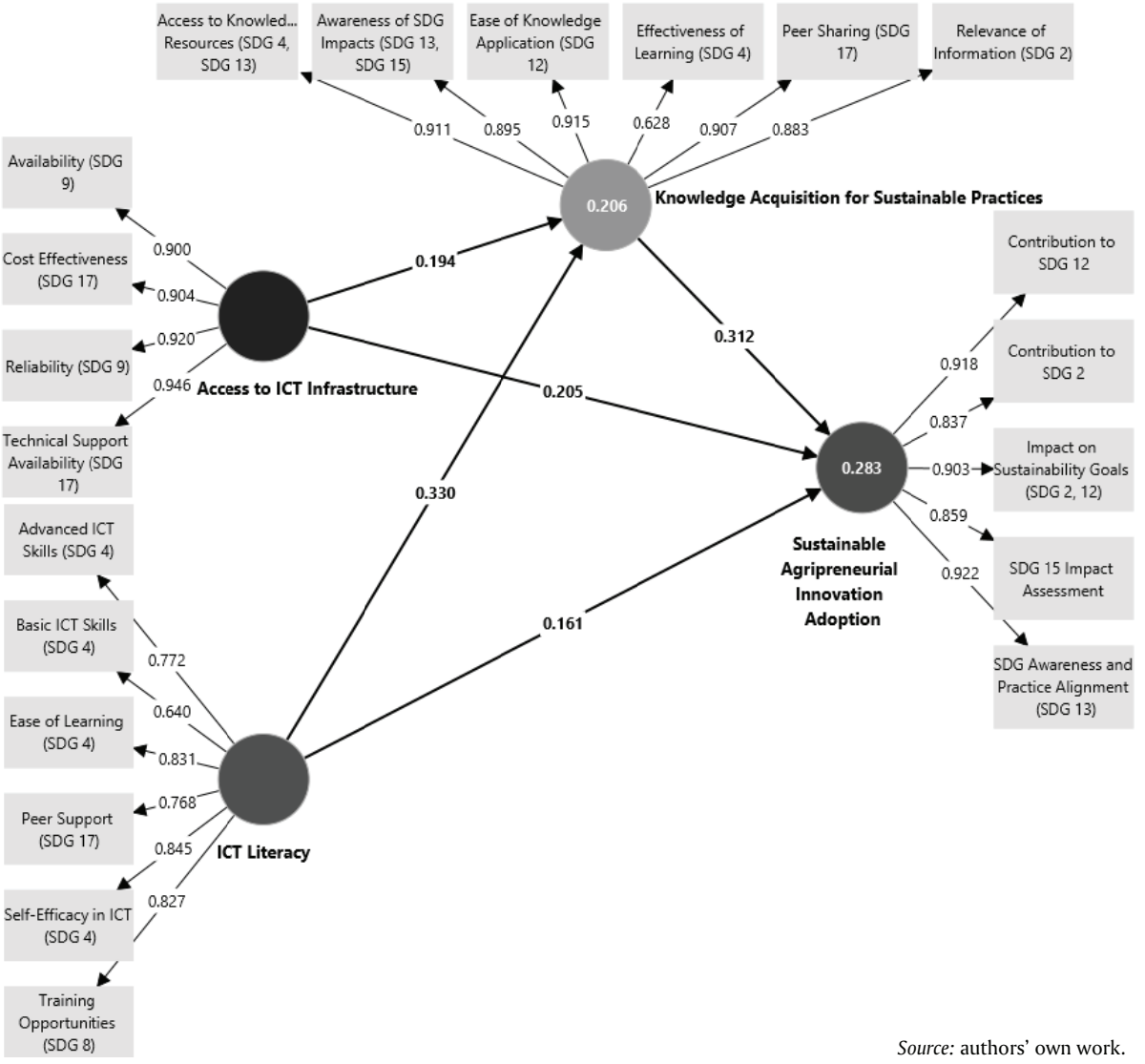
The results depicted in the PLS structural model (Figure 2) illustrate the relationships and influence of ICT literacy and access to ICT infrastructure on knowledge acquisition for sustainable practices and its subsequent impact on sustainable agripreneurial innovation adoption. The path coefficients (e.g. 0.330, 0.205, 0.161) indicate the strength and direction of relationships, the R^2 values (0.206 and 0.283) demonstrate the explanatory power of dependent variables, and the outer loadings validate the constructs' reliability, highlighting significant contributions of SDG-aligned variables such as ease of learning, cost-effectiveness, and technical support to sustainability goals.

The construct reliability and validity results (Table 5) indicate strong internal consistency and convergent validity for all constructs. This is evidenced by high Cronbach's alpha (ranging from 0.873 to 0.937) and composite reliability (rho_c ranging from 0.904 to 0.955), along with average variance extracted (AVE) values exceeding the threshold of 0.50 (ranging from 0.614 to 0.842), confirming that the measurement model is robust and reliably captures the intended dimensions of access to ICT infrastructure, ICT literacy, knowledge acquisition for sustainable practices, and sustainable agripreneurial innovation adoption.

The Heterotrait-Monotrait Ratio (HTMT) values (Table 6), all below the recommended threshold of 0.85 (ranging from 0.369 to 0.495), confirm the discriminant validity of the constructs, indicating that access to ICT infrastructure, ICT literacy, knowledge acquisition for sustainable practices, and sustainable agripreneurial innovation adoption are empirically

Figure 2

PLS Algorithm/Conceptual Model



Source: authors' own work.

Table 5
Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Access to ICT infrastructure	0.937	0.939	0.955	0.842
ICT Literacy	0.873	0.874	0.904	0.614
Knowledge acquisition for sustainable practices	0.927	0.931	0.945	0.744
Sustainable agripreneurial innovation adoption	0.933	0.938	0.949	0.789

Source: authors' own work.

Table 6
HTMT

Particulars	Heterotrait-monotrait ratio (HTMT)
ICT literacy <-> Access to ICT infrastructure	0.495
Knowledge acquisition for sustainable practices <-> Access to ICT infrastructure	0.369
Knowledge acquisition for sustainable practices <-> ICT literacy	0.453
Sustainable agripreneurial innovation adoption <-> Access to ICT infrastructure	0.402
Sustainable agripreneurial innovation adoption <-> ICT literacy	0.411
Sustainable agripreneurial innovation adoption <-> Knowledge acquisition for sustainable practices	0.479

Source: authors' own work.

distinct while maintaining meaningful interrelationships.

The hypothesis testing results in Table 7 confirm that all the hypothesised relationships are statistically significant, as indicated by high t-statistics (ranging from 2.735 to 5.944) and low p-values (≤ 0.006). This demonstrates that access to ICT infrastructure positively influences both knowledge acquisition for sustainable practices ($\beta = 0.194$, $p = 0.001$) and sustainable agripreneurial innovation adoption ($\beta = 0.205$, $p = 0.002$), ICT literacy significantly impacts knowledge acquisition ($\beta = 0.330$, $p = 0.000$) and innovation adoption ($\beta = 0.161$, $p = 0.006$), and knowledge acquisition strongly drives sustainable agripreneurial innovation adoption ($\beta = 0.312$, $p = 0.000$), thereby validating the critical role of ICT resources and literacy in fostering sustainability-aligned innovations.

Table 7
Hypothesis Testing

H_0: Hypothesis	Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*P* values	Comments
H1	Access to ICT infrastructure –> Knowledge acquisition for sustainable practices	0.194	0.194	0.058	3.352	0.001	Supported
H2	Access to ICT infrastructure –> Sustainable agripreneurial innovation adoption	0.205	0.207	0.067	3.036	0.002	Supported
H3	ICT literacy –> Knowledge acquisition for sustainable practices	0.330	0.333	0.056	5.944	0.000	Supported
H4	ICT literacy –> Sustainable agripreneurial Innovation adoption	0.161	0.161	0.059	2.735	0.006	Supported
H5	Knowledge acquisition for sustainable practices –> Sustainable agripreneurial innovation adoption	0.312	0.313	0.057	5.506	0.000	Supported

Source: authors' own work.

Discussion

The conclusions from our analysis indicate a significant favourable consequence of access to ICT infrastructure and ICT literacy on knowledge acquisition for sustainable practices, which in turn entirely influences sustainable agribusiness innovation adoption. These associations are in line with the academic bases that underpin the adoption of Information and Communications Technology integrated resolutions in farming and green growth of the agricultural sector.

The robust association amongst access to ICT infrastructure and knowledge acquisition for sustainable practices reveals that augmented access to Information and Communications Technology infrastructure equips agrarian agripreneurs with a practical understanding of sustainable approaches, a consequence that is uniform with previous analyses (e.g. Maniriho, 2024) that highlight how potent Information and Communications Technology infrastructure enables bridge knowledge apertures, particularly in resource-constrained agrarian backdrops.

Additionally, the connection between Access to ICT infrastructure and sustainable agripreneurial innovation adoption demonstrates that enhanced digital connectivity and technical accessibility facilitate the adoption of ingenious and sustainable agrarian practices. This finding parallels the developments of Klimova et al. (2016) and Somers and Stapleton, (2012) who discovered that agriculturalists with steadfast internet access and Information and Communications Technology resources were more willing to incorporate environmentally amicable techniques and progressive agri-tech resolution.

Case Study for Policy Implications

Additionally, a case study of E-Choupal has been included to provide a practical perspicuity into agripreneurial innovations ameliorated by ICT. The case mentioned provides an assessment of how leveraging ICT can help achieve the SDGs through the development of rural economies (Mathew, 2018).

E-Choupal combines information technology and agricultural practices to foster the development of an agripreneurial class, enabling informed decision-making based on knowledge-driven practices. The platform is established by ITC (Indian Tobacco Company). The e-Choupal initiative epitomises the transformative integration of Information and Communication Technologies (ICT) in agripreneurial ecosystems, facilitating a paradigm shift in rural agricultural practices by empowering farmers through digital enablement—leveraging decentralised kiosks that provide real-time meteorological insights, market intelligence, and agronomic advisories, thereby circumventing traditional supply chain bottlenecks, enhancing price discovery mechanisms, and fostering agripreneurial self-reliance in an era marked by technological convergence and disruptive innovation in the global agribusiness landscape. The given platform provides access to ICT infrastructure, which is not possible for an individual farmer or a group of farmers to develop. This accessibility provides reliable and pocket-friendly information to farmers, accompanied by technical support to inform their decision-making. The presence of the most up-to-date and accurate information brings innovation to agricultural ventures, facilitating the sustainable adoption of farming practices. If a farmer (agripreneur) can acquire ICT literacy, knowledge of sustainable practices becomes practical, promoting innovative advancements in sustainable agriculture.

Limitations of the Study

The present study provides meaningful insights into introducing sustainability to the lives of farmers through ICT-based decision-making, but there are a few limitations that need to be specified, despite their relatively minor impact. The present study employs the PLS SEM quantitative research technique while excluding qualitative statistical methods, as they were outside the scope of the current study. The technique of the PLS Algorithm and Bootstrapping is applied in the current research, rather than CB-Based SEM, as it does not involve an exact application of the theory. The present study demonstrates high internal consistency and convergent validity, ensuring that the constructs accurately reflect their underlying concepts; however, it over-relies on internal consistency metrics without addressing potential response biases. Additionally, the application of HTMT may result in conceptual overlap, although multiple tests confirm that the constructs are distinct and well-defined, provided they are grounded in more robust qualitative validation.

Conclusion

The present research shows a statistically significant connection between the dependent and independent variables. The results obtained from the analysis provide beneficial insights by clarifying the terms of policy-making for achieving sustainability in farming, while at the same time, in framing policies, maximum importance must be given to knowledge acquisition, as it has a maximum beta value of 0.312, which means that knowledge has the most decisive influence on innovation adoption in sustainable farming. The second most influential predictor is Access to ICT, which impacts sustainable agriculture, as well as statistically significantly influences the response variable and should therefore play a significant role in the policy framework for rural development. The ICT infrastructure must be accessible to all farmers and should be within their purchasing power, considering their economic status, with the government supposed to give subsidies or interest-free loans to farmers who are willing to adopt ICT infrastructure. The last explanatory variable is ICT Literacy, which is also found to be statistically significant but with the lowest beta value of 0.161. However, despite the minimum value of beta, its contribution to impacting the dependent

variable cannot be ignored, as it has a p-value of less than 0.05, making it necessary to develop a practical framework to raise awareness about the usage and benefits of ICT in achieving the goal of sustainable agriculture. In a nutshell, it is essential to embrace all input variables in policy formulation to achieve a robust impact on sustainable entrepreneurial innovation adoption.

The appendix is available in the online version of the journal.

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