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Understanding Psychological Well-being Process of Medical Students with Emphasis on Technostress: A Structural-qualitative Model

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ABSTRACT

Objective: The goal of this study was to present a model for psychological well-being of students with an emphasis on the role of technostress in the context of medical education in health.

Methods: The present research was conducted with a qualitative approach using grounded theory. The research participants were experts familiar with technostress phenomenon in medical education who were chosen through purposive sampling and theoretical saturation. Thus, the data collection process was completed using a total of 22 semi-structured interviews, and data analysis was done during three phases: open, axial and selective coding. To enhance validity and reliability of results, strategies such as model review and documentation of analytic steps by experts were utilized.

Results: The causal conditions of technostress were functional dependence upon technology, cognitive strain, technological insecurity, concerns regarding error and evaluation, stress of continued updating, digital multitasking and individual-technology conflict. These circumstances shaped students' approach to technology in interaction with contextual factors as well as intervening factors, namely features of university educational environment as. Action and interaction strategies in institutional and individual levels reduced technostress and promoted the psychological well-being of students.

Conclusions: Psychological well-being of students in technology-based educational environments is a function of synergy between institutional university strategies with individual student approaches for managing the technostress. Supportive and empowering interventions should be designed in both levels.

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Introduction

In recent decades, the integration of digital technologies into daily life has transformed the ways people learn, communicate, and interact with their environment (Thianthai & Tamdee, 2024). The COVID-19 pandemic significantly accelerated digital transformation processes in higher education, leading to widespread reliance on digital tools for instruction, communication, and mental health support (Apostol et al., 2023). These changes have confronted university environments with both opportunities and challenges arising from digitalization. While online learning offers flexibility and easier access to resources, it also brings numerous challenges, including technostress. Technostress refers to the psychological discomfort or strain that individuals experience as a result of technology use, particularly when they are unable to cope with its demands (Saleem et al., 2024).

International studies indicate that the prevalence of technostress among medical sciences students ranges from 50% to 75%, and this phenomenon is associated with outcomes such as anxiety, mental fatigue, academic burnout, reduced life satisfaction, and impaired psychological well-being (Wu et al., 2022; Ayyagari et al., 2011). In this regard, research has shown that factors such as information overload, digital multitasking, and technological insecurity play an important role in exacerbating technostress (Kumar, 2024; Cazan et al., 2024). Tarafdar et al. (2019) distinguished between positive (eustress) and negative (distress) forms of technostress, emphasizing that the outcomes of technostress largely depend on an individual's cognitive appraisal and available resources. From the perspective of Lazarus and Folkman's (1984) cognitive appraisal theory of stress, stress occurs when an individual appraises environmental demands as exceeding their resources. Hobfoll et al.'s (2018) conservation of resources theory similarly emphasizes the importance of preserving valued resources (such as digital skills and social support) in coping with technological pressures.

In Iran, the expansion of virtual education systems following the COVID-19 pandemic brought about significant changes in higher education practices. Although these developments provided opportunities for the continuity of education, they were also accompanied by challenges such as weak technological infrastructure, difficulty in using educational platforms, reduced academic interaction, and limitations in certain learning experiences (Rakhgireh et al., 2024; Nami et al., 2024). Findings also indicate that students' knowledge of and attitudes toward virtual education

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vary, and that effective use of this mode of instruction requires increasing their awareness and competence in utilizing educational technologies (Hemati et al., 2025). Nevertheless, most domestic [Iranian] studies have focused on describing experiences of virtual education, with relatively little attention paid to examining the structural relationships between technology-related pressures and psychological well-being.

At the international level as well, the majority of technostress research has been conducted in occupational settings, and the limited studies conducted in educational settings have often relied on univariate analyses or simple correlations (Fischer et al., 2023). Furthermore, the specific conditions of medical sciences education — including a high density of academic content, extensive reliance on technology, and the need for continuous access to digital resources — place students in this field at greater risk of technostress than other groups (Wong et al., 2023). Despite this heightened vulnerability, dedicated research systematically modeling the relationship between technostress and psychological well-being among Iranian medical sciences students remains very scarce. Accordingly, the present study was conducted with the aim of developing an indigenous model of psychological well-being with a focus on technostress among medical sciences students.

Material and Methods

The present study aimed to develop and explain a model of university students' psychological well-being, with an emphasis on the role of technostress. This qualitative study employed a grounded theory approach. Its philosophical foundation was rooted in the interpretive paradigm and the perspective of social constructionism, which emphasizes understanding and interpreting meanings constructed through individuals' lived experiences within their social contexts. Within this framework, the researcher systematically analyzed empirical data to identify concepts and theoretical relationships associated with the phenomenon under investigation.

The participants comprised three groups: medical sciences students, faculty members, and specialists in mental health or educational technology. The selected students had completed at least three years of university education and reported continuous experience using educational platforms, virtual classes, and e-learning technologies. Faculty members had at least five years of teaching experience and experience using educational technologies in classroom instruction, virtual education, or the production of electronic learning content. The third group consisted of

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counselors, psychologists, and medical education specialists who, in addition to their professional backgrounds, had academic or practical experience in the areas of student mental health or educational technology. All participants were capable of providing detailed and meaningful accounts of the phenomenon under investigation.

The sampling process began with purposive sampling. As the analysis progressed and initial concepts emerged, theoretical sampling was employed to further elaborate the dimensions of the phenomenon. Data collection continued until theoretical saturation was achieved. In total, 22 interviews were conducted. Data analysis indicated that no new idea or concept emerged after the twentieth interview, while the information obtained from the twenty-first and twenty-second interviews merely reinforced the previous findings. Accordingly, theoretical saturation was confirmed. The interviews were conducted primarily at Hamadan University of Medical Sciences, with arrangements made to meet the participants at their workplaces or places of study. In some cases, the interviews were conducted online.

Data were collected through semi-structured interviews. The interview protocol was developed based on the paradigm model of grounded theory and was designed to cover the causal, contextual, intervening, strategic, and consequential dimensions of the phenomenon. The main questions addressed participants' experiences of engaging with educational technologies, factors contributing to technology-related stress, organizational conditions that intensified or reduced technostress, strategies used by students to manage technology-related pressures, and the consequences of this phenomenon for psychological well-being. Follow-up questions were also asked in response to participants' answers in order to deepen the semantic richness of the data.

Data analysis was conducted in accordance with the systematic approach proposed by Strauss and Corbin (1998), using the constant comparative method. During open coding, initial concepts were extracted from the data. Subsequently, during axial coding, similar concepts were organized into coherent categories, and the relationships among them were identified within the framework of the paradigm model. During selective coding, the core category of the study was identified, and the other categories were integrated around it to develop the final research model.

To ensure the credibility and dependability of the data and findings, several standard strategies were employed. Portions of the interview transcripts and the initial interpretations were sent to the participants to verify the accuracy of the researchers' interpretations. In addition, the extracted

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codes, categories, and relationships were reviewed and confirmed by several experts familiar with qualitative research methodology and medical education. All stages of data collection and analysis were documented to ensure the auditability and traceability of the research process. Furthermore, peer review was used to enhance the reliability of the findings. Accordingly, a portion of the data was independently coded by another researcher, and the results indicated an acceptable level of agreement between the coding processes.

Results

This section presents the findings obtained from the qualitative phase of the study, which was conducted to explore and explain the process through which technostress develops and its consequences for psychological well-being. Accordingly, by adopting a qualitative approach and employing grounded theory, the present study sought to extract the main categories, influential conditions, action/interaction strategies, and consequences associated with technostress through the three-stage process of open, axial, and selective coding. These findings were subsequently presented in the form of the study's conceptual model.

Open Coding

In the present study, data were collected through 22 semi-structured interviews with academic experts and students at a university of medical sciences, with the aim of developing a model of psychological well-being focusing on the phenomenon of technostress. Following completion of the data-collection process, data analysis began concurrently with data collection, based on the grounded theory approach and using open coding. At this stage, through repeated, line-by-line, and comparative examination of the interview transcripts, the researcher sought to identify and formulate the meanings embedded in the participants' lived experiences without imposing predetermined theoretical assumptions.

Open coding was conducted to break the data down into small meaning units, label phenomena, and reveal initial concepts. In this process, each sentence, phrase, or meaningful segment of the interview text that conveyed an experience, feeling, perception, or interpretation related to educational technologies, technostress, and its psychological consequences was treated as an analytical unit and assigned an appropriate conceptual label. This approach made it possible to

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preserve the complexity and diversity of the participants' experiences without prematurely reducing the data.

Accordingly, a total of 312 initial codes, including repetitions, were extracted from the interview transcripts. These codes reflected a broad range of participants' individual, organizational, and technological experiences in relation to digital education and technology-related stressful conditions. In the next step, the researcher used constant comparison to refine, merge, and cluster similar and related codes. In this process, the conceptual similarities and differences among the codes were examined carefully.

The outcome of this analytical process was the identification of 89 distinct concepts, each representing a relatively stable pattern of meaning within the data. These concepts were then organized, on the basis of their conceptual and substantive relationships, into 18 main categories. These categories provided the analytical foundation for the subsequent stages of data analysis, including axial coding and the development of the final paradigm model. They also facilitated a systematic explanation of the relationships among the causal conditions, strategies, and consequences associated with psychological well-being and technostress in the university context. The following section presents an example of the open-coding process for the main category "Students' Level of Skills and Individual Capital."

Main Category: Students' Level of Skills and Individual Capital

This category refers to the extent to which students possess digital literacy, technological self-efficacy, previous successful experiences with technology, and psychological readiness to learn and adapt to digital tools. The level of these skills and forms of capital determines the extent to which students can effectively employ technostress-reduction strategies when confronted with the technological demands of education.

In this study, interviewees repeatedly referred to a situation in which a lack of initial experience generated anxiety and performance-related concerns. However, through gradual learning, practice, and increased mastery, this anxiety decreased and, in some cases, a positive attitude toward technology developed. From this perspective, individual skills function as a moderating contextual condition that enables the implementation of active coping strategies for managing technostress.

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Interview 1

"For me, the use of technology—both hardware and software—has so far had two dimensions. One has genuinely been related to my academic and professional work, which I am still using technology for. I try to explore new technologies when they emerge, see how I can connect with them, figure out how I can work with them, or participate in training courses. For example, for about a year now there has been extensive discussion about artificial intelligence tools in education and research. The first thing I did was enroll in a training course to become familiar with these tools, understand where each of them could be useful, learn how to work with them, and determine the extent to which I could use them…"

Interview 2

"Technology has made work easier in some respects, but because the necessary culture has not been established, expectations have increased considerably. For example, the system is useful because I no longer need to search the entire hospital to find a laboratory result or an imaging report. However, if you do not have the necessary skills or if expectations are unrealistic, the very thing that is supposed to help becomes a source of pressure. Some patients and visitors expect us to know all patients' information accurately and completely simply because the system is in front of us. The number of patients is high, but they do not understand this. As a result, we are constantly under pressure and experience stress."

Interview 16

"Our greatest fears and stress occur when we do not know what to do and enter an environment without adequate knowledge. Imagine someone who does not know how to drive and has no previous driving experience. If you suddenly give that person a car and tell them to drive on, for example, a busy highway, they will experience extremely high levels of stress and tension. This may also cause harm to themselves and others. In my opinion, before introducing someone into a driving environment—or any other environment—we should first teach them how to drive and familiarize them with the relevant rules. Therefore, when we know the guidelines for using these platforms, understand the appropriate procedures, and know how to upload a file when the internet is disconnected or how each shortcut works within the platforms, we will no longer experience such high levels of stress."

Table 1. Main Category: Students' Level of Skills and Individual Capital

Open codes	Concepts	Main category
Prior familiarity with educational software; lack of initial experience and the emergence of anxiety at the beginning of use; gradual learning after several sessions of use	Initial digital literacy	Students' level of skills and individual capital
Successful experience working with technology after a period of trial and error; reduced anxiety after "getting into the rhythm"; feeling comfortable after achieving relative mastery	Previous successful experience	Students' level of skills and individual capital
Active search for learning new tools; spontaneous and voluntary acquisition of technological skills; using technology beyond minimum requirements	Technological self-efficacy	Students' level of skills and individual capital
Use of guides and prior training; need for training before formal requirements are imposed; reduced stress when introductory training is provided	Educational readiness and prior learning	Students' level of skills and individual capital
Feeling competent in managing an online class or educational activity; increased self-confidence when interacting with systems; reduced concern about making errors	Technological self-confidence	Students' level of skills and individual capital
Improved time management after mastering technology; faster completion of educational and research-related tasks; feeling in control of the learning process	Individual performance capital	Students' level of skills and individual capital

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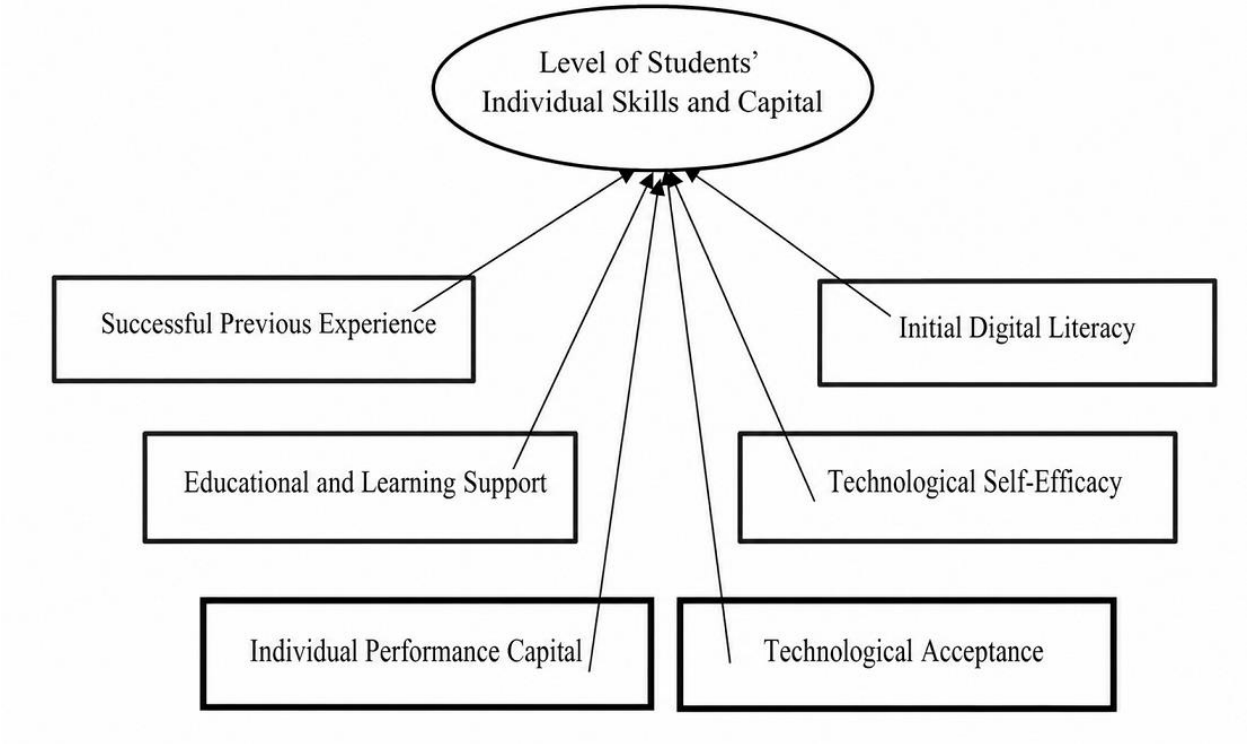


Figure 1. Main Category: Students' Level of Skills and Individual Capital

Axial Coding

Following the completion of open coding and the identification of the initial concepts and categories, axial coding was conducted to systematically organize the categories and explain the relationships among them.

As a transition from open coding to a higher level of analysis, axial coding was used to establish systematic connections among the extracted categories. At this stage, the data were analyzed not as isolated units but as an integrated conceptual and process-oriented structure in order to explain how the phenomenon under investigation emerged, persisted, and produced its consequences.

The analytical framework for this stage was based on the paradigm model proposed by Strauss and Corbin. Accordingly, the categories were organized into six components: the central phenomenon, causal conditions, contextual conditions, intervening conditions, strategies, and consequences. This reorganization was conducted through constant comparison of the data, examination of the contexts in which the phenomenon occurred, and analysis of the actions and interactions undertaken in response to it. In this way, the causal and interactive relationships among the

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categories were clarified, and the position of each category in explaining the central phenomenon was determined.

Table 2. Paradigm Model of Axial Coding for Students' Psychological Well-Being with a Focus on Technostress

Axial category	Main categories	Concepts (initial codes)
Causal conditions	Functional dependence on technology	Comprehensive occupational dependence; functional reliance on technology; structural dependence; dependence on technology for decision-making
	Technology-induced cognitive pressure	Cognitive load resulting from the rapid transformation of technology; cognitive ambiguity and complexity; information overload; performance-related cognitive anxiety; technological preoccupation
	Technological insecurity and concerns about errors and evaluation	Anxiety about technological errors; infrastructural insecurity; information insecurity; digital evaluation anxiety; erosion of professional self-efficacy
	Stress associated with continuous updating	Pressure for continuous learning; dynamic technological dependence; technology-related economic stress
	Digital multitasking	Overlapping digital roles; simultaneous technological disruptions; digital performance pressure; reduced cognitive control
	Person–technology conflict	Technology-imposed cognitive load; perceived inability to cope with technology; cognitive–psychological exhaustion; technology-driven structural pressure
Contextual conditions	Students' level of skills and individual capital	Initial digital literacy; previous successful experience; technological self-efficacy; educational readiness and prior learning; technological self-confidence; individual performance capital
	Students' psychological capital	Initial stressful encounters with technology; experiential and gradual learning; technological self-efficacy; tolerance of ambiguity and technological errors; experience-based situational resilience; psychological–educational readiness; perceived control over technological situations
	Attitudes toward and acceptance of technology within the university culture	Process-oriented acceptance of technology; instrumental–functional attitude toward technology; technological cultural pressure; level of institutional efforts to promote a technology-oriented culture
	Quality of design and user-friendliness of educational technologies	System performance instability; functional disruption of educational tools and the resulting psychological pressure; mismatch between technology design and users' actual working conditions; lack of physical spaces and facilities supporting educational technology; inappropriate design of infrastructural and support services, including internet and network systems
	University environmental, organizational, and policy support	Organizational training and empowerment as a means of reducing technostress; organizational preparedness and learning in response to technological crises; service and financial support and the reduction of performance-related anxiety; policy flexibility and enhancement of perceived psychological control; infrastructural predictability and psychological safety; integrated organizational support and reduction of psychological exhaustion
Intervening conditions	Characteristics of the university educational environment	Instability of the digital environment and momentary anxiety arousal; critical dependence on networks and performance-related psychological pressure; limited environmental resources and increased mental tension; environmental disruption and threats to professional performance; incompatibility between environmental equipment and the requirements of educational technology; lack of physical spaces supporting digital education; mismatch between the work environment and increased cognitive load
Strategies	Active learning and student empowerment	Improvement of digital literacy; experiential and gradual learning of technology; gradual mastery and normalization of working with technology; perceived technological self-efficacy; empowerment through prior training and organizational support
	Gradual exposure to technology and	Institutional gradualization of exposure to technology; management of the initial cognitive–emotional shock; cognitive–emotional regulation with university support; cognitive–emotional normalization of technology

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	cognitive–emotional normalization of its use	
	Implementation of technological empowerment programs to enhance perceived control	Implementation of technological empowerment programs; creation and development of sustainable technological support structures; policy and executive flexibility in managing technology-based education
	Active management of digital exposure to improve students' psychological well-being	University governance of students' digital experiences; redefining the role of technology in the educational experience; cognitive management of the digital experience; psychological safeguarding of the digital environment; well-being-oriented approach to technology management
Consequences	Reduction or control of technostress	Reduced experienced technology-related pressure; reduced technological confusion; increased ability to cope with technostress; regulation of the time pressure associated with technostress; reduced instability in the technological experience; increased individual control over technology
	Enhancement of students' psychological well-being	Reduced technology-related psychological tension; increased feelings of competence and self-efficacy; reduced cognitive and mental load; increased psychological safety; enhanced sense of control and predictability; improved psychological balance and reduced exhaustion

Selective Coding: Emergence of the Research Model

In the final stage of data analysis, selective coding was conducted to integrate the extracted categories and develop the theoretical core of the study. At this stage, the analysis moved beyond merely describing the relationships among the categories and focused on identifying a central category capable of connecting the other categories within a coherent framework and explaining the overall logic of the phenomenon under investigation.

This stage was based on the results of open and axial coding and was conducted through constant comparison of the data and repeated rereading of the participants' narratives. During this process, the identified categories were reassessed to determine which category had the greatest explanatory capacity for clarifying the relationships among the causal conditions, contextual conditions, intervening conditions, strategies, and consequences.

The selection of the core category was based on criteria such as its frequency and prominence in the data, its conceptual relationship with the majority of the categories, its ability to explain the phenomenon as a process, and its capacity to provide a coherent theoretical narrative. Accordingly, the core category of the study was formulated as: "Students' psychological well-being, with a focus on technostress within the context of university education."

This category indicates that students' psychological well-being in technology-based educational environments is neither a static phenomenon nor one independent of context. Rather, it develops

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as a dynamic process in which students seek to maintain and enhance their psychological well-being by regulating and managing their experiences of technostress.

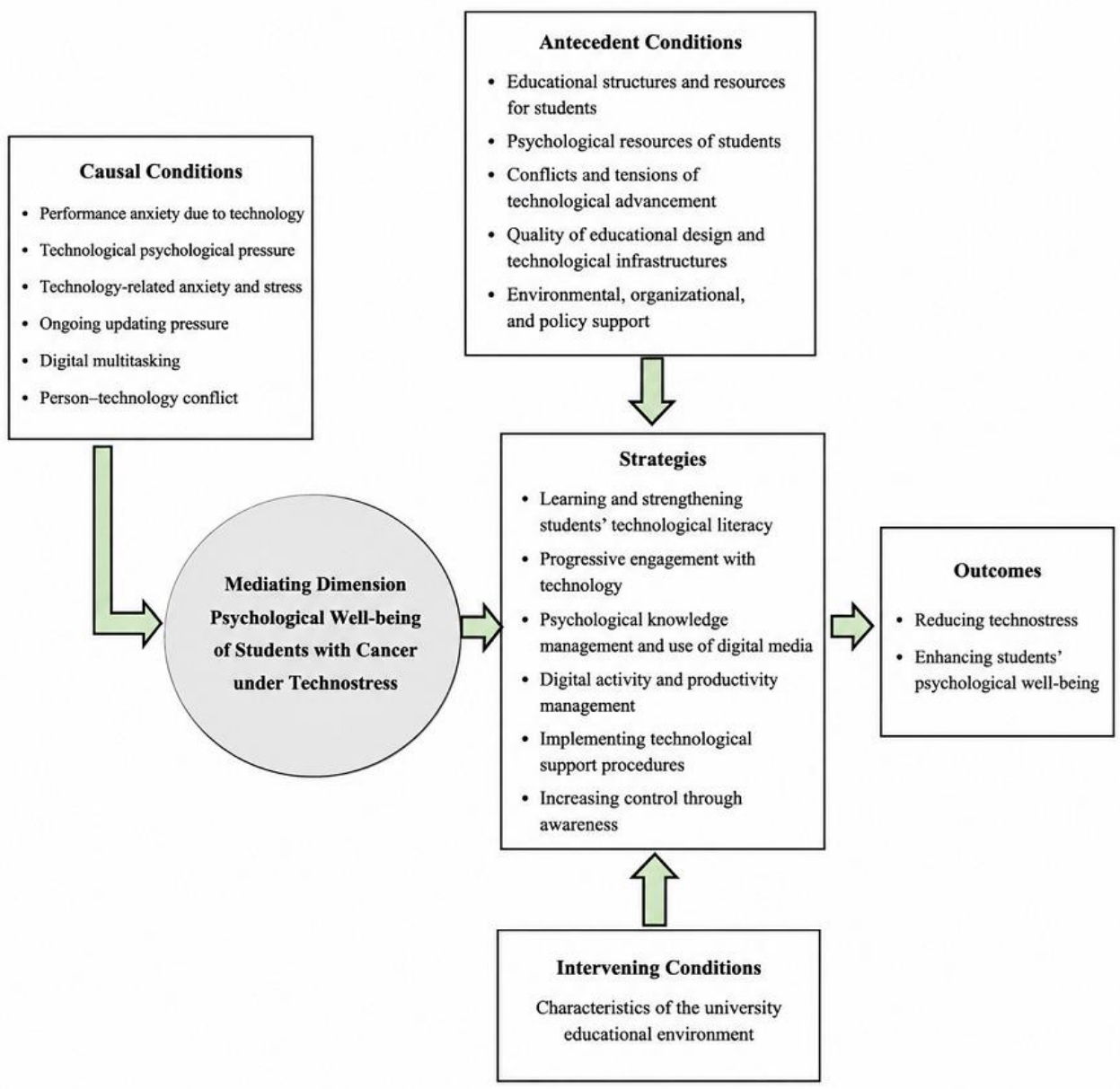


Figure 1. Selective Coding and Students' Psychological Well-Being with a Focus on Technostress

Discussion

The main findings of the study indicated that students' psychological well-being in technology-based educational environments is a dynamic and interactive process shaped by the relationship

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among causal conditions—including functional dependence on technology, cognitive pressure, technological insecurity, continuous updating stress, digital multitasking, and person–technology conflict—contextual conditions—including individual skills and capital, psychological capital, attitudes toward and acceptance of technology within the university culture, the quality of technology design, and environmental, organizational, and policy support—intervening conditions, namely the characteristics of the university educational environment, action and interaction strategies at both institutional and individual levels, and outcomes, including the reduction of technostress and the enhancement of psychological well-being.

The core category of the study indicates that effective management of technostress, achieved through the synergy between university- and student-level strategies, can help maintain psychological balance in digital environments. These findings are consistent with Lazarus and Folkman's cognitive appraisal theory of stress (Lazarus & Folkman, 1984) and Hobfoll's conservation of resources theory (Hobfoll et al., 2018), both of which emphasize the role of subjective appraisal and resource preservation in coping with stress. Furthermore, the strategies identified in this study reflect key components of Deci and Ryan's self-determination theory (Deci & Ryan, 2000) and Bakker and Demerouti's job demands–resources model (Bakker & Demerouti, 2017).

The findings of this study are consistent with those of previous research. Wu et al. (2022) demonstrated that technological complexity and dependence on digital tools are among the most important factors contributing to technostress. Similarly, Kumar (2024) and Kazen et al. (2024) reported that, in addition to its cognitive consequences, technostress affects the quality of academic performance. In the present study, participants also referred to cognitive fatigue, technological anxiety, and feelings of psychological confusion.

Saleem et al. (2024) highlighted the role of instructor support and appropriate infrastructure in reducing technostress. Consistent with these findings, organizational support was identified in the present study as both a contextual and an intervening condition. Neagu and Vieriu (2025) emphasized the dynamic and context-dependent nature of digital well-being, while Tek and Özsari (2025) demonstrated that digital literacy has a protective role—a finding that is consistent with the results of the present study. In addition, Yangzee Sherpa et al. (2025) confirmed the role of

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information overload and digital multitasking in increasing psychological pressures, which corresponds to the findings of this study.

Overall, the model developed in this study, with its emphasis on the interaction among individual, institutional, and contextual factors, can provide a foundation for designing preventive interventions and developing effective policies in the area of student mental health in the digital age.

Practical Implications

Based on the findings of the study, several practical recommendations can be proposed for administrators and policymakers in universities of medical sciences.

First, designing and implementing educational programs to enhance students' digital literacy and skills can improve their ability to use educational technologies effectively. Second, revising the design of e-learning systems with an emphasis on user-friendliness and the reduction of unnecessary complexity can create a more satisfactory user experience. Third, establishing technical and educational support mechanisms to address students' technology-related problems can prevent many of the tensions associated with technology use.

Fourth, expanding counseling services and psychological support programs aimed at managing stress arising from digital environments can contribute to improving students' mental health. Fifth, empowering faculty members to use educational technologies in a balanced and supportive manner can play an important role in creating a safer and less stressful learning environment.

Limitations

Despite its contributions, the present study had several limitations that should be considered when interpreting the findings. The qualitative nature of the study and the use of in-depth interviews required considerable time to access participants and complete the data-collection process. In some cases, coordinating interview schedules with participants was challenging.

Moreover, identifying and recruiting specialists who were knowledgeable and experienced in the subject of the study was time-consuming and required repeated follow-up. In addition, because the study focused on a specific university setting, the generalizability of its findings to other universities or educational environments may be limited.

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Conclusion

Overall, the results indicate that students' psychological well-being in technology-based educational environments does not depend solely on the extent of technology use. Rather, factors such as the quality of educational-system design, the level of institutional support, students' technological skills, and the way interactions with technology are managed play decisive roles in shaping psychological well-being.

Accordingly, the conceptual model developed in this study demonstrates that psychological well-being in technology-oriented learning environments results from the dynamic interaction among causal, contextual, and intervening conditions, as well as action and interaction strategies. Simultaneous attention to these components can help reduce the negative consequences of technostress and improve the quality of the learning experience among students in the health sciences.

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Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by ethics committee of University of Tehran.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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