The role of applied research in master's professional studies within the Information Technology study program

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Abstract: The paper first presents the legislative framework of master's professional studies in the Republic of Serbia through the explanation of terms in the Law on Higher Education and corresponding bylaws, as well as in the Law on the National Qualifications Framework of the Republic of Serbia. Afterwards, a comparison of fundamental and applied research is conducted based on several criteria. The role and significance of applied research in master's professional studies are explained, with a special focus on the Information Technology master's study program within the master's professional studies at the Information Technology School – ITS. The paper elaborates on why the role of applied research in master's professional studies is crucial for developing practical skills in students, their industry integration, and gaining practical experience.

Keywords: applied research, master's professional studies, information technology

1. Introduction

Science, as one of the most important channels of knowledge, "has a specific role, as well as a series of functions for the benefit of our society: creating new knowledge, improving education, and increasing the quality of our lives" [1]. Research constitutes the foundation of science. There are different criteria for classifying research, and one possible criterion is "based on the purpose of research", according to which fundamental and applied research are distinguished.

Research work represents a fundamental element of the higher education system, defined in the Republic of Serbia by the Law on Higher Education [2] and the Law on Science and Research. According to the Law on Higher Education, higher education activities are carried out through academic and professional studies.

The aim of this paper is to explore the role of applied research in master's professional studies, with a specific emphasis on the significance of applied research in the educational process and its contribution to the development of students' professional skills.

The paper first explains the legislative framework of master's professional studies in the Republic of Serbia, followed by an explanation of the distinction between fundamental and applied research. The central part of the paper analyzes the role and significance of applied research in master's professional studies. The importance of acquainting students with the basic principles of applied research and how they positively impact problem identification from practice and the application of scientific methods for their resolution, innovation and creativity in finding new solutions, how they improve existing processes, products, or services, and how they contribute to societal and economic development are highlighted. Special attention is given to the master's professional studies at the Information Technology School (ITS), where the course "Basics of Applied Research" is taught within the Information Technology study program. The aim of this course is explained, and its importance in the preparation of master's theses is emphasized.

2. Legislative framework of master's professional studies in the Republic of Serbia

The higher education system, conditions, and methods of conducting higher education in the Republic of Serbia are regulated by the Law on Higher Education [2]. Article 34 of the Law on Higher Education defines that the activity of higher education is conducted through academic and professional studies based on accredited study programs for acquiring higher education. The main goal of the professional study program is for students to gain specialized knowledge and skills, which they will be able to apply to effectively integrate and participate in the work process.

There are two levels of professional studies: undergraduate professional studies and specialized professional studies - first-degree studies. The scope of undergraduate professional studies is 180 ECTS credits, while the scope of specialized professional studies is at least 60 ECTS credits after completing undergraduate professional studies.

Master's professional studies are second-degree studies and include a minimum of 120 ECTS credits. This implies that before enrolling in master's professional studies, the scope of first-degree studies, either academic or professional studies, of at least 180 ECTS credits, needs to be fulfilled. Master's professional studies were introduced through amendments to the Law on Higher Education in September 2014. The accreditation of the first master's professional study programs started a few years later.

In the Law on the National Qualifications Framework of the Republic of Serbia, which connects the national framework with the European Qualifications Framework, professional studies (undergraduate, specialized, and master's professional studies) are defined as one of the four types of qualifications [3]. Article 5 of the Law on the National Qualifications Framework of the Republic of Serbia defines qualification levels, where sub-level 7.1, achieved by completing master's professional studies, is denoted as 7.1 S [3].

Based on Article 12 of the Law on Higher Education, the National Council for Higher Education has adopted sublegal acts that mention master's professional studies, among other things, which are:

- Regulation on Standards and Procedures for Accrediting Study Programs and
- Regulation on Standards and Procedures for Accrediting Higher Education Institutions.

The standards for accrediting study programs and standards for accrediting higher education institutions are integral parts of these two regulations. Master's professional studies are mentioned in three standards for accrediting study programs: Standard 1 – Structure of the Study Program; Standard 5 – Curriculum, and Standard 9 – Teaching Staff. Additionally, master's professional studies are mentioned in two standards for accrediting higher education institutions: Standard 4 – Studies and Standard 6 – Teaching Staff.

Article 40, paragraph 2, of the Law on Higher Education, defines that "the study program of master's academic and master's professional studies includes the obligation to complete a final thesis" [2]. According to the Regulation on Standards and Procedures for accrediting Higher Education Institutions, point 4.1.4 of Standard 4 defines that qualifications indicating the completion of master's professional studies are acquired by students who are, among other things, "qualified to solve practical problems in business enterprises and public institutions" [5]. The resolution of practical problems and the completion of a final thesis are interconnected in point 5.16 of Standard 5 – Curriculum of the Regulation on Standards and Procedures for Accrediting Study Programs, where it is defined that the "final thesis in master's professional studies is a project that solves a practical problem" [4].

Given that solving practical problems falls within the domain of applied research, it follows that the final thesis in master's professional studies belongs to the domain of applied research. Due to these reasons, the need for the subject "Basics of Applied Research" emerged.

3. Comparison of fundamental and applied research

The fundamental characteristics of applied research become evident when compared to fundamental research. Although there is no unique definition of applied research, several factors can help distinguish whether a research is fundamental or applied. Some potential factors include the research goal, applicability of research results, research outcomes, and collaboration with relevant interest groups.

Fundamental research is focused on acquiring fundamental knowledge, understanding basic principles and theories, and expanding existing knowledge in a specific field. The primary objective of fundamental research is to expand human knowledge [6]. Applied research, on the other hand, is directed towards solving practical problems, and applying existing knowledge, scientific methods, and theories to achieve specific goals or enhance certain processes, products, or services. Therefore, the primary aim of applied research is to increase knowledge that can be easily and practically applied [1].

In addition to the research goal, fundamental and applied research also differ in the applicability of research results. Fundamental research often does not have immediate practical applications but is oriented towards developing theoretical frameworks, models, and principles. However, the results of fundamental research can serve as a basis for future research projects. In contrast, applied research has an immediate practical focus on creating practical solutions and has a direct impact on industry, society, or individuals. The results of applied research can lead to new products, methodologies, or approaches that can be applied in the real world. Based on the above, the main drawback of applied research is that its results cannot be generalized because they are exclusively limited to the research problem.

Fundamental research is characterized by uncertain outcomes because it deals with more general knowledge. It often happens that the progress achieved through fundamental research conditions the progress of applied research. However, in the history of science, there have also been cases where the results of applied research influenced fundamental research and expanded the boundaries of scientific knowledge.

Fundamental research is conducted in academic environments such as universities and research laboratories. Since applied research is directed towards solving specific problems, it often involves collaboration with industry, society, or other relevant interest groups.

In addition to the mentioned differences, fundamental and applied research can be compared by analyzing answers to questions about why and how research is conducted while considering the following parameters: time, resources, research conditions, and research methods [6]. The key differences between fundamental and applied research are presented in Table 1.

Table 1. Key differences between fundamental and applied research [6].

	Fundamental Research	Applied Research
Objective	Expanding understanding and knowledge of the world. Discovering universal laws.	Assisting clients in solving specific practical problems.
Who proposes?	Researcher based on their knowledge, research skills, and interests.	Client based on their needs for addressing a specific situation or problem.
Who funds?	Usually government, universities, and private foundations.	Client pays consultants or employees in the company. Funds are typically much lower than what is needed for fundamental research.
Who executes?	Individual researcher, typically from one scientific discipline, occasionally a project team.	Employees in the company or consultant(s). Ideally, the research team should consist of experts from relevant disciplines.
Timeframe	Usually longer compared to applied research.	Depends on the deadlines set by the client. Significantly shorter deadlines than ideal for research.
Research conditions	Research may be independent of real-world conditions.	Research is conducted inseparably from real-world conditions.
Research methods	Usually involves only a few different data sources and data collection methods. Data collection and data analysis methods typically depend on the researcher's capabilities.	Efforts are made to combine multiple data collection methods from different sources and to combine qualitative and quantitative data analysis methods.
Evaluation	Presentation at scientific conferences and publication in peer-reviewed journals.	Presentation and submission of reports solely to the client, who is the sole evaluator of results. The client decides whether and how to use the results and whether to publish them.

Regardless of the mentioned differences, fundamental and applied research employ the same methods. Additionally, applied research often uses results obtained from fundamental research, making these two types of research mutually complementary [6].

4. The role and significance of applied research in master's professional studies

Master's professional studies allow students to acquire advanced knowledge and skills in a specific professional field. Since the final master's professional thesis represents a project in which students need to solve a practical problem, there is a need for students to master the basics of applied research during their studies.

The fundamentals of applied research are a novelty in domestic literature, as they appear as a subject in master's professional studies introduced by amendments to the Law on Higher Education in September 2014. The aim of this subject is to enable students in master's professional studies to understand what applied research is and how it is conducted, as well as to familiarize them with all phases of the research process – from identifying and formulating a problem, through finding literature and processing results, to writing a report on the conducted research and publishing the results.

The role of applied research in master's professional studies is not only about solving real problems but also plays a significant role in developing students' practical skills and improving their professional competencies.

By solving practical problems and conducting applied research within the framework of master's professional studies, students apply theoretical knowledge in real situations, providing them with an opportunity to connect with industry and gain practical experience. In doing so, students use all relevant knowledge in the field to which the research problem belongs. Some of this knowledge they acquire during their undergraduate studies, some they gain during their master's professional studies, and some they may need to acquire themselves, depending on the nature of the project [6]. Applied research enables students to collaborate with various industry experts, allowing them to face the challenges of interdisciplinary work. In this way, students develop crucial skills such as critical thinking, analytical skills, teamwork, communication skills, and leadership. These skills are of paramount importance in the modern business environment.

Through working on their final master's professional thesis, students have the opportunity to become acquainted with real problems in the economic or public sectors and provide suggestions for their resolution. During the process of solving a specific problem, students apply scientific methods, collect and analyze data, make decisions, implement solutions, and conduct an analysis of the implemented solution. In this way, through applied research, students gain practical experience and receive feedback from industry experts. Additionally, students develop a network of professional contacts that will be valuable to them when looking for a job.

Students engaged in applied research have the opportunity to be innovative and creative, potentially arriving at new solutions or improving existing processes, products, or services during the completion of their master's professional thesis. Thus, applied research directly contributes to the development of society. The drivers of positive change are precisely the students in master's professional studies who, through applied research, address current problems, improve processes, products, or services, create new technologies, solve societal challenges, and thereby enhance all aspects of quality of life.

By mastering the fundamental principles of applied research and conducting applied research during the work on their master's professional thesis, students develop and enhance a multitude of skills characteristic of researchers, such as powers of observation, analytical and synthesis abilities, determination, creativity, a willingness to think unconventionally, responsibility, honesty, diligence and accuracy, initiative, critical thinking and self-critique, a desire to collaborate, and systematicity [6].

5. The role of applied research in master's professional studies at ITS within the Information Technology study program

Information Technology School (ITS) accredited second-degree studies – master's professional studies in the Information Technology program in 2017. Master's professional studies at ITS provide a wide range of knowledge in various fields of information technology, such as data science, IT security, advanced programming, and advanced computer multimedia.

Given that the final thesis in master's professional studies represents independent professional work in which a practical problem is solved, there is an obvious need for a course Basics of Applied Research. The primary goal of the Basics of Applied Research course is to acquaint students with all phases of the research process – from identifying problems, through writing reports on conducted research, to publishing results, with a focus on applied research in the field of information technology.

Learning outcomes have also been defined for the Basics of Applied Research course, which is mandatory according to accreditation standards in higher education [7]. At ITS, students are introduced to the learning outcomes of the subject at the beginning of each class. Experience and research conducted at ITS have shown that "defined and communicated learning outcomes help students choose and master the study program and subjects" [7]. After learning the subject matter of the Basics of Applied Research, students will be able to engage in applied research work, explain the place of applied research in scientific research activities, formulate their ideas, and establish the initial assumptions for problem-solving. Additionally, they will know how to critically approach selecting literature, present and evaluate the results of their research, and compare their results with those of other researchers. Students will learn how to present research results to clients and/or the public, write professional papers, and apply ethical principles in research work.

Since ITS has accredited the Information Technology study program within the master's professional studies, it is clear that the topic of the master's professional thesis represents a project in which practical problems are solved through the application of information technology. It is desirable for the project to originate from the economic or public sector. As solving practical problems falls within the domain of applied research, knowledge of applied research is essential. Guidelines for writing, as well as areas in information technology for a master's professional thesis, are provided in the "Guidelines for the Preparation of a Master's Professional Thesis at ITS" [8]. This document defines, among other things, that the master's professional thesis "includes the formulation, analysis of one or more research problems in the field of information technology, the application of research methods, interpretation, discussion of solutions, and a conclusion with recommendations." The key assumption of the master's professional thesis is that the student independently solves a practical problem using information technology, whether it involves their own research or the interpretation of results from other researchers.

To date, at ITS over 30 students have successfully defended their master's professional theses in various IT areas, including Cloud Computing, Software Quality Assurance, UI Design, Graphic Product and Interior Design, Big Data, 3D Graphic Systems, Digital Forensics, Cryptography, Data Science, Machine Learning, Data Mining, Advanced Techniques in 3D Modeling and Animation, Data Security, Application and Computer Networks, Applied Web and Mobile Application Programming, and Video Games. For the realization of each of these projects, or the application of a research approach to problem-solving, knowledge acquired in the Basics of Applied Research course was essential for the students.

6. Conclusion

This paper has explained the role and significance of applied research in master's professional studies. It has demonstrated why the role of applied research in master's professional studies is crucial for developing practical skills among students, connecting them with the industry, and gaining practical experience.

The implementation of applied research within the framework of master's professional studies directly impacts society by solving real problems and developing new solutions. The course "Basics of Applied Research" should encourage students to think like researchers and adopt a research-oriented approach to problem-solving. This will help them address various types of challenges and respond effectively to the demands of the modern work environment.

Special attention in this paper has been given to the master's professional studies at the Information Technology School (ITS) and the Information Technology study program. The role of the subject "Basics of Applied Research" and its significance in the preparation of the master's professional thesis has been explained. As over 30 students have successfully defended their master's professional theses at ITS, future research could involve an analysis of students' experiences in conducting applied research and its benefits in their careers. Furthermore, it is possible to analyze the results of applied research, i.e., the outcomes presented in master's professional theses, and their impact on the industry and society. To conduct such future research, it will be necessary to define methods for evaluating the success of applied research, establish measurement and evaluation criteria for research outcomes, and define how feedback can be used to improve future research.

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