Athens Journal of Education

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Front Pages

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Published by the Athens Institute

Athens Institute is an Athens-based World Association of Academics and Researchers based in Athens. Athens Institute is an independent and non-profit Association with a Mission to become a forum where Academics and Researchers from all over the world can meet in Athens, exchange ideas on their research and discuss future developments in their disciplines, as well as engage with professionals from other fields. Athens was chosen because of its long history of academic gatherings, which go back thousands of years to Plato's Academy and Aristotle's Lyceum. Both these historic places are within walking distance from Athens Institute's downtown offices. Since antiquity, Athens was an open city. In the words of Pericles, Athens"…is open to the world, we never expel a foreigner from learning or seeing". ("Pericles' Funeral Oration", in Thucydides, The History of the Peloponnesian War). It is Athens Institute's mission to revive the glory of Ancient Athens by inviting the World Academic Community to the city, to learn from each other in an environment of freedom and respect for other people's opinions and beliefs. After all, the free expression of one's opinion formed the basis for the development of democracy, and Athens was its cradle. As it turned out, the Golden Age of Athens was in fact, the Golden Age of the Western Civilization. Education and (Re)searching for the 'truth' are the pillars of any free (democratic) society. This is the reason why Education and Research are the two core words in Athens Institute's name.

The **Athens Journal of Education** (AJE) is an Open Access quarterly double-blind peer reviewed journal and considers papers from all areas of history. Many of the papers published in this journal have been presented at the various conferences sponsored by the Education Unit of the Athens Institute. All papers are subject to Athens Institute's Publication Ethical Policy and Statement.

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Athens Journal of Education
Editorial and Reviewers' Board

President's Message

All Athens Institute's publications including its e-journals are open access without any costs (submission, processing, publishing, open access paid by authors, open access paid by readers etc.) and is independent of presentations at any of the many small events (conferences, symposiums, forums, colloquiums, courses, roundtable discussions) organized by Athens Institute throughout the year and entail significant costs of participating. The intellectual property rights of the submitting papers remain with the author. Before you submit, please make sure your paper meets the basic academic standards, which includes proper English. Some articles will be selected from the numerous papers that have been presented at the various annual international academic conferences organized by the different divisions and units of the Athens Institute for Education and Research. The plethora of papers presented every year will enable the editorial board of each journal to select the best, and in so doing produce a top-quality academic journal. In addition to papers presented, Athens Institute will encourage the independent submission of papers to be evaluated for publication.

The current issue is the third of the thirteenth volume of the *Athens Journal of Education (AJE), published by the Education Unit of Athens Institute.*

Gregory T. Papanikos
President
Athens Institute

Athens Institute for Education and Research

A World Association of Academics and Researchers

29th Annual International Conference on Education
17-29 May 2027, Athens, Greece

The Education Unit of Athens Institute organizes its **29th Annual International Conference on Education, 17-20 May 2027, Athens, Greece** sponsored by the Athens Journal of Education. The aim of the conference is to bring together scholars and students of education and other related disciplines. You may participate as stream leader, presenter of one paper, chair a session or observer. Papers (in English) from all areas of education are welcome. Please submit a proposal using the form available (https://www.atiner.gr/2027/FORM-EDU.doc).

Academic Members Responsible for the Conference

- **Dr. Gregory T. Papanikos**, President, Athens Institute
- **Dr. David Philip Wick**, Director, Arts, Humanities and Education Division, Athens Institute & Professor of History, Gordon College, USA.
- **Dr. Nick Linardopoulos**, Head, Education Unit, Athens Institute & Associate Teaching Professor & Public Speaking Course Coordinator, Rutgers University, USA.
- **Dr. John Spiridakis**, Co-Editor, Athens Journal of Education & Professor, St. John University, USA.

Important Dates

- Abstract Submission: **20 October 2026**
- Acceptance of Abstract: 4 Weeks after Submission
- Submission of Paper: **19 April 2027**

Social and Educational Program

The Social Program Emphasizes the Educational Aspect of the Academic Meetings of Athens Institute.

- Greek Night Entertainment (This is the official dinner of the conference)
- Athens Sightseeing: Old and New-An Educational Urban Walk
- Social Dinner
- Mycenae Visit
- Exploration of the Aegean Islands
- Delphi Visit

Conference Fees

Conference fees vary from 400€ to 2000€
Details can be found at: https://www.atiner.gr/fees

10th Annual International Symposium on "Higher Education in a Global World", 6-10 July 2026, Athens, Greece

The Education Unit of Athens Institute is organizing the 10th **Annual International Symposium on "Higher Education in a Global World", 6-10 July 2026, Athens, Greece** sponsored by the Athens Journal of Education. The aim of the symposium is to examine educational developments throughout the world in universities, polytechnics, colleges, and vocational and education institutions. Academics and researchers from all areas of education are welcomed. You may participate as stream organizer, presenter of one paper, chair a session or observer. Please submit a proposal using the form available (https://www.atiner.gr/2026/FORM-COLEDU.doc).

Important Dates

- Abstract Submission: **DEADLINE CLOSED**
- Acceptance of Abstract: 4 Weeks after Submission
- Submission of Paper: **8 June 2026**

Academic Member Responsible for the Conference

- **Dr. Gregory T. Papanikos**, President, ATINER.
- **Dr. Sharon Claire Bolton**, Vice President of Research, Athens Institute & Professor, The Management School, University of Stirling, Scotland.
- **Dr. David Philip Wick**, Director, Arts, Humanities and Education Division, Athens Institute & Professor of History, Gordon College, USA.
- **Dr. John Spiridakis**, Co-Editor, Athens Journal of Education & Professor, St. John University, USA.
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- Ancient Corinth and Cape Sounion

More information can be found here: https://www.atiner.gr/social-program

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The ABD (All but Dissertation) Cohort Program: Challenges and Opportunities

By Eleni Coukos Elder, Twianie Roberts± & Janet Finch°*

The Department of Educational Leadership at Tennessee State University (TSU) faced a significant challenge in the Fall of 2023. Nearly 100 students had completed their doctoral coursework; however, they had not completed their dissertations. The majority of the students were nearing or exceeding the maximum time allowed of 10 years to complete their doctoral programs. Many students had requested extensions due to the global pandemic, further complicating the situation. The *All But Dissertation (ABD) Cohort Program* was developed and designed to address this issue and assist students in successfully completing their dissertations. The department recognized this as an opportunity to implement a targeted intervention and provide necessary support and strategies to engage, motivate, and help students succeed. Currently, the *ABD Cohort Program* has achieved significant success in helping students complete their dissertations. Of the 100 ABD students, 40 have completed a prediction completion rate of 90+%. Students have until December 2025 to complete the program. Based upon a recent Student Satisfaction Survey, students expressed elevated levels of satisfaction with the program and the support they have received. This paper will provide an overview of the program's structure, key components, faculty involvement, successful outcomes, lessons learned, and recommendations. Key takeaways will include: the importance of policy considerations; the importance of targeted support and mentorship; the benefits of a structured program with clear guidelines; and, the value of incorporating Artificial Intelligence (AI) tools into the dissertation process.

Keywords: doctoral persistence, dissertation completion, ABD cohort program

Introduction

Time to complete a doctoral degree continues to increase. The current time for completing a doctoral degree averages about 13.7 years (Church & Duran, 2022). The doctoral degree is pursued by 100,000 students each year (McAlpine & Amundsen, 2021). Yet, between 40-60% of these doctoral students are making the decision to discontinue work toward a degree they have already invested significant amounts of time, money, and energy into earning (Jackson & Michelson, 2023).

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Statement of the Problem

The Department of Educational Leadership at Tennessee State University (TSU) faced a significant challenge in the Fall of 2023. Nearly 100 students had completed their doctoral coursework; however, they had not completed their dissertations. The majority of the students were nearing or exceeding the maximum time allowed (ten years) to complete their doctoral programs according to the university's graduate catalog. Many students had requested extensions due to the global pandemic, further complicating the situation. These students either had to drop out of the program altogether or be readmitted with an appeal to the Graduate School for a time extension.

Background of Study

The Office of Academic Affairs recognized this lack of doctoral student completion as an opportunity to implement a targeted intervention and provide necessary resources and strategies to engage, motivate, and encourage these individuals to push through and finish. As a result, the *All But Dissertation (ABD) Cohort Program* was created and designed to address this issue by providing a structured program to support and assist these students in successfully completing their dissertations.

Most universities apply time limitations for completing degree requirements. At TSU, the policy states that, "credits earned more than ten (10) years prior to the student's graduation cannot be applied toward meeting requirements for the Ed.D. or Ph.D. degrees" (*TSU Graduate Catalog*, 2024-2025).

The policy further states that:

> Extension of time for completing course requirements may occasionally be granted because of interruptions in graduate studies due to extenuating circumstances, such as family leave, illness, or military services.
> All petitions to extend the program of study beyond the degree program time limits must be submitted by the student before the courses expire, using the Graduate School *Appeal/Petition Form*. Following a positive recommendation by the Advisor, Department Head, and Academic Dean, the petition will be sent to the Graduate School for review by the Graduate Council Appeals Committee, and finally the Graduate Council. The decision of the Graduate Council is final. Extensions will be granted with the following stipulations.
> There will be only one such extension granted, for a time period specified on the Appeal/Petition Form. Courses taken outside the degree program time limits may not be counted toward the degree unless they are **revalidated** [emphasis added] to demonstrate that mastery of knowledge/skills is current. Revalidated courses are added back to the Program of Study. The plan for revalidation must be prepared in conjunction with the student's major department and submitted with the Appeal/ Petition Form.

Mechanisms for revalidating out-of-date courses are limited to the following:

- re-taking expired courses; or
- re-taking related courses (equal in credit hours to the expired courses) approved by the department, and added to the Program of Study; or
- **re-taking a competency test** (qualifying or **comprehensive examination**) [emphasis added] administered by the department…

Revalidation will only apply to courses on the approved Program of Study or approved as transfer credit for inclusion in the Program of Study. Students who have been out of school for one or more semesters must apply for readmission to Graduate School. If approved for an extension, documentation of completion of the approved revalidation plan must be submitted to the Graduate School by the department, and the Program of Study must be submitted or revised to indicate revalidated courses (*TSU Graduate Catalog*, 2024-2025).

According to the Graduate School's policy on Extension of Time Limitations (*TSU Graduate Catalog*, 2024-2025): the university outlines a strict time limit for completing doctoral programs (10 years). However, there were some limitations. For instance, the policy did not adequately account for exceptional circumstances such as the global pandemic. There was a need for flexibility. It became evident that a more flexible approach was necessary to support the students facing unique challenges.

These select ABD individuals (approximately 100) were contacted at the end of the Fall 2023 semester and asked if they would be interested in participating in an ABD Bootcamp Cohort with other students in the same position as themselves. The program would be a structured program with monthly group informational meetings. There would be mentor guidance and group support. The Department Chair explained to them that the Department would prepare a blanket appeal for time extensions on behalf of all the students who were interested in participating in the program. They were told they would have to be finished with their dissertation, all program requirements, and graduated by December 2025, or they would be permanently dropped from the program.

The Department Chair and faculty, with support from the College of Education Dean and Vice President for Academic Affairs petitioned the Graduate Council at TSU for an exception to time limit, citing the extraordinary circumstances faced by the ABD students. The blanket justification petition highlighted the impact of the pandemic on students' academic progress and the need for additional time to complete their dissertations. The department requested a time extension until December 2025 to allow all interested ABD students to complete their doctoral degree. A revalidation of each student's program of study was requested which required that each student revalidate courses older than 10 years. This revalidation was done by having each student complete a 350–400-word paper (with resources) for *each* course that had exceeded the 10-year time limit.

Purpose and Organization of the Paper

This paper provides an overview of faculty's experience with the development of the *ABD Cohort Program*. Information is included on: (a) significance of this project, (b) the guiding research questions, (c) a description of Vincent Tinto's *Theory of Involvement and Student Departure* as the theoretical framework focusing on graduate education, (d) a review of the related literature including challenges and barriers to dissertation completion, (e) targeted interventions, (f) the foundation of the *ABD Cohort Program* including its key components and faculty involvement, (g) successful outcomes, (h) lessons learned, and (i) recommendations.

Significance of Project

The significance of this project lies in its potential to contribute to the understanding of doctoral student attrition, especially at the dissertation stage of their program. Attrition at any level of post-secondary education is costly to both students and higher education institutions. Doctoral students are often funding their own education while balancing careers, families, and/or studies. There is immense potential on society and educational institutions if more students complete the programs that they have started and invested in financially and emotionally.

There are endless barriers and challenges that doctoral students, especially part-time students, face. Barriers may include personal or individual challenges or institutional or departmental barriers. This study hopes to bring to the forefront many of the challenges that have hindered many doctoral students from completing their dissertations, and therefore, their degrees. Thus, allowing faculty to fully understand and help provide students with opportunities to intervene with strategies for motivation and success.

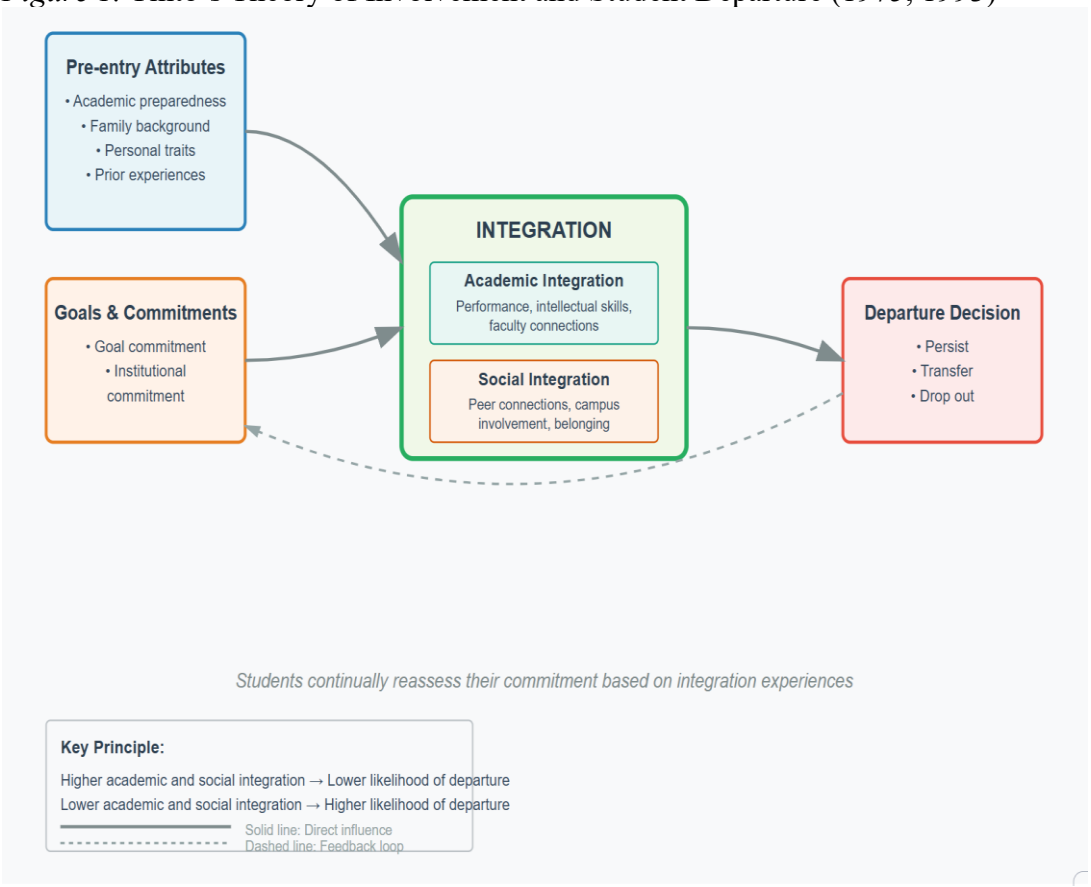
Guiding Research Questions

1. What are some common barriers and challenges doctoral students face while completing their dissertations? (personal and institutional)
2. How are comparable doctoral programs addressing similar attrition issues?
3. How is participating in the *ABD Cohort Program* impacting persistence to degree completion? (benefits)

Theoretical Framework: Tinto's Theory of Involvement and Student Departure

According to Vincent Tinto, the theorist credited with developing the most comprehensive theoretical model of persistence and withdrawal behavior (1975, 1993), higher education institutions are made up of distinct *social* and *academic* systems. Integration into these systems, which reflects a student's judgement of *fit* within an unfamiliar environment, represents perceptions on the part of the student of shared values and support in the college community. See Figure 1.

Figure 1. Tinto's Theory of Involvement and Student Departure (1975, 1993)



Tinto's theory seeks to explain the reasons why some college students drop out of school while others persist and graduate. The key components of the theory are the concepts of academic and social integration (the center part of Tinto's model). *Academic Integration* refers to a student's academic performance, their personal development of intellectual skills, and their satisfaction with the school's academic systems. Students who do well grade-wise and connect with faculty and staff are more integrated. *Social Integration* refers to how socially connected and involved students are in college life. Making friends, joining groups or clubs, and bonding with peers and faculty members denotes higher

social integration. Tinto argues that students who become more academically and socially involved in college life are less likely to drop out.

Other key aspects of the theory include: (a) *Pre-entry Attributes*, where students come to college with certain background characteristics and prior experiences that influence their commitment to completing college. This includes things like academic preparedness, personality traits, family background, etc.; (b) *Goals and Commitments*, where students have varying levels of commitment to the goal of college graduation and to the institution they are attending. Important levels of commitment make students more likely to persist; and, (c) *The Departure Decision,* which is the result of students continually reassessing their commitment to graduating and/or staying at the current institution.

Literature Review

The literature review for this project aimed to provide information and research on (a) the common barriers and challenges students encounter toward dissertation completion, (b) necessary supports for doctoral students, (c) the impact of targeted dissertation intervention programs on degree completion, and (d) strategies to engage, motivate, and help doctoral students succeed.

Barriers to Completion

The dissertation pathway is different for each person. Each student brings with him or her his or her own characteristics, set of skills (i.e., research, statistical, typing, grammar, writing, notetaking, synthesizing, editing), knowledge of the dissertation process, and background. The students are no longer following a prescribed program of study where they are told what to do. There are both personal and institutional barriers to dissertation completion. Doctoral students face significant challenges in completing their dissertations, with attrition rates ranging on an average of 50% (Burns & Gillespie, 2018). Several factors contribute to this high dropout rate, including stress, social isolation, procrastination, and perfectionism (Garrison & Vaugh, 2023). The transition from coursework to independent research is particularly difficult for many students (Lovitts, 2008). In addition to personal, individual obstacles there are programmatic, or institutional, barriers to completing the dissertation. Among these barriers include: lack of program flexibility (McAlpine, Castello, & Pyhältö, 2022) and faculty mentoring (Levine & Nettles, 2023; O'Meara, Griffin, Kuvaeva, Nyunt & Robinson, 2017).

A critical question in doctoral education is why students who succeed in the coursework (dependent) phase of their graduate education have different fates in the independent research phase of their education. In one focus group–based study, faculty were asked to talk about students who had difficulty making the transition to independent research or who did not make it at all. They were also asked to talk about students who made the transition to

independent research with relative ease. The focus group discussions were analyzed using a theoretical perspective derived from theory and research on creativity and degree completion. The descriptions of students who made the transition with relative success matched closely with characterizations of highly creative people (Lovitts, 2008). Yet, this is but one study.

Tinto's Theory and Doctoral Student Attrition

Tinto's *Theory of Student Involvement and Departure*, when applied to doctoral students abandoning their programs before dissertation completion, reveals several key insights related to the core elements of Tinto's theory. Tinto's model emphasizes that student persistence depends on successful academic and social integration into the institutional community. For doctoral students specifically, this manifests in unique ways. Academic integration becomes more specialized. It may involve transition from coursework to independent research; development of scholarly identity within their discipline; mastery of specialized methodologies and literature; meaningful relationships with advisors/mentors. Moreover, it encompasses the elements of social integration at the doctoral level and may include: integration into departmental culture and academic community; development of professional networks with faculty and peers; participation in disciplinary communities beyond the institution; and, balancing academic demands with external commitments. Isolation during dissertation writing and limited peer support after coursework completion are two quite common issues.

In relation to social and academic integration, some research findings include Golde's (2019) expanded work that integration challenges differ by discipline, with humanities students facing particular isolation challenges during the dissertation phase. Bueno's follow-up study (2023) found that efficacy of Ed.D. lecturers in supporting students in developing research skills and competencies was found to be essential in graduate education. Stewart and Cole (2022) found that the role of peer communities and structured interventions lent to the fostering of belonging in graduate education.

Understanding doctoral attrition through Tinto's lens highlights the critical importance of both academic and social integration, while recognizing the unique developmental journey doctoral students undertake as they transition from students to independent scholars. Gardner's work (2021) tracked doctoral students across disciplines, confirming that integration factors predicted completion rates, with departmental culture being particularly influential during the dissertation phase. Furthermore, Gonzalez and Martinez's research (2020) demonstrated that sense of belonging (a key aspect of social integration) was significantly correlated with persistence for underrepresented doctoral students.

Moreover, doctoral students face distinct challenges during dissertation stage that align with Tinto's framework and goal commitment issues. These challenges may include: unclear or shifting career aspirations; diminishing perceived value of the degree; competing professional opportunities; and, research fatigue and isolation during dissertation phase.

Additionally, institutional commitment problems include challenges such as: inadequate mentorship or advisor conflicts; limited departmental support structures; insufficient funding opportunities; and, lack of clear milestones and expectations. Regarding advisor-student relationship research, Pifer and Baker (2023) quantified the impact of mentoring quality on dissertation completion, finding that students with regular, constructive advisor interactions were 3.7 times more likely to complete their degrees. O'Meara et al. (2022) showed that transparency in advising expectations and clear communication about research milestones significantly reduced time-to-degree and attrition rates. Additional research revealed that students who receive social support through regular interactions with their advisors tend to complete their degrees more quickly than students whose advisors do not provide as much feedback (Maddox & Wilson, 2023).

Identity development research revealed how scholarly identity formation impacts persistence, finding that students who viewed themselves as contributing members of their academic community showed greater resilience during dissertation challenges (Castelló et al. 2024). Baker and Pifer (2020) tracked the transition from student to scholar identity, confirming this as a critical factor in dissertation persistence. With regard to external factors and support systems, Martinez et al. (2022) demonstrated the effectiveness of structured writing groups in increasing social integration and dissertation progress. Whereas O'Meara, et al, (2021) quantified how financial support during the dissertation phase reduced attrition by 46%, underscoring the impact of external pressures.

Recent mixed-methods studies (Devos et al., 2022) have created more nuanced models of doctoral persistence that build upon Tinto's framework while incorporating discipline-specific factors. Bair and Haworth's comprehensive meta-analysis (2020) synthesized 30 years of doctoral attrition research, confirming that integration factors consistently predict completion across all time periods studied. These studies collectively validate Tinto's core principles while extending them to address the unique characteristics of doctoral education. The research consistently shows that both academic and social integration remain powerful predictors of dissertation completion, though the specific mechanisms may differ from undergraduate contexts.

Impact of Targeted Dissertation Intervention Programs on Degree Completion

Recent research on intervention strategies for ABD (All But Dissertation) students highlights various approaches to improve dissertation completion rates. Workshops focusing on dissertation writing and research skills have shown promise in supporting students (Burrus et al., 2019; Kania-Gosche & Leavitt, 2011). These interventions can include peer review activities, literature review processes, and problem definition exercises. Shifting from traditional dissertations to implementing intensive research-focused workshops has been identified as predictors of online doctoral student success (Burrus et al., 2019). Successful interventions often involve institutional resources, structured strategies,

and conscious leadership to develop programs that promote equity and improve completion rates for diverse student populations (Martinez-Colon & Richardson, 2022; Posselt & Miller, 2023).

Progress-oriented workshops have shown promise in improving doctoral well-being and addressing dropout rates by focusing on productivity, mental health, and progress perception (Prieto et al., 2022). Qualitative case studies have identified key themes in successful dissertation completion interventions, including extrinsic factors, socioemotional support, formal program structures, and personal development (Franklin & Morales, 2023). Interventions have shown promise in increasing students' success beliefs, writing skills, and emotional well-being (Prieto et al., 2022). Key components of successful programs include providing a supportive environment, offering individualized attention, and incorporating activities that make progress visible (Prieto et al., 2022).

Students who are enrolled in part-time programs benefit from cohorts, which allow for additional peer support (Hodson & Buckley, 2023; Jackson & Michelson, 2023). The definition of *cohort* can vary with how it is used. In the book *College Student Retention*, Tom Mortenson defines *cohort* as the identification of a clearly defined group of students at one point in time and place with specific demographic and enrollment characteristics (Gardner & Gopaul, 2012). Maher, Wofford, Roksa, and Feldon (2021) defined *cohort* as a group of students who begin at the same time and emphasize the benefits of networking, support, ease in scheduling and satisfaction after graduation. Students in a cohort are better prepared (West, et al. 2011). Cohort models have shown to beneficial for community development (Garrison, & Vaughan, 2023; Lei, Gorelick, Short, & Smallwood, 2021; Peterson, & Dill, 2022), socialization (Maher, Wofford, Roksa, & Feldon, 2021), and in distance learning and virtual communities (Bettencourt, Malaney, Kidder, & George, 2022; Pemberton, & Akkary, 2022; Rockinson-Szapkiw, Spaulding, & Bade, 2022).

Lehan, Hussey, and Holtz (2021) recommended the cohort model and outlined four stages of the doctoral program: (a) the entry stage, (b) the skill and development stage, (c) the consolidation state, and (d) the completion stage. Tinto (1993) outlined three stages as a student maneuvers throughout the doctoral degree process, transition, candidacy, and dissertation. Sawicka & Pretorius (2023) conducted a literature review of the states of doctoral education and categorized three stages: knowledge consumption, knowledge creation, and knowledge enactment. West, et al. (2011) reported two stages: the course stage, which is structured and familiar, and the dissertation stage which is unstructured and unfamiliar. Tinto's (1993) first and second stages could be considered dependent stages due to their structured format while his third could be classified as independent or unstructured and unfamiliar to the student.

The ABD Cohort Program Design: The Boot Camp

Dissertation writing is often the most challenging part of the doctoral program for many students. A large number of them never make it past this point. In an effort to raise completion rates and as well as increase student

satisfaction with the program, professors in our Ed.D. program developed the *ABD Cohort Program* to support students with the dissertation process.

Designing a program for the ABD students seemed intuitive. First, all ABD students and faculty advisors were added to an online eLearn community. In that space, synchronous workshops were held, and many resources were housed. The *ABD cohort program* consisted of a series of monthly workshops focused on specific areas of the dissertation process. Workshop topics included: conducting a literature review, selecting a research design and drafting a chapter three, developing a presentation-ready proposal—Chapters 1-3, preparing an IRB application with all related documentation (CITI ethics training, consent forms, permissions), training on Qualtrics survey software and IBM SPSS software, among others. See Figure 2 for the complete list of ABD Boot Camp topics and deliverables. The workshops were recorded and saved on the ABD eLearn course site. These recordings are available to all ABD students and future students.

Figure 2. *The ABD Cohort Program Topics and Schedule of Monthly Workshops*

	Boot Camp Topics – Month 2024 First Monday of the Month	Deliverable Due Dates - Last Day of the Month
January	Conducting Literature Review	Extended Bibliography – min 100 primary sources* within five years unless the work is seminal. Min 20 dissertations from ProQuest if possible. Dissertation Committee Formed
February	Introduction / Statement of the Problem/Purpose of Study/ Significance/ Research Questions	Conceptual Framework Due
March	Outline of Chapter 2	**Chapter 1** Purpose of Study and Research Questions Theoretical Framework Due
April	Research Design	**Chapter 2** – Literature Review
May	Proposal Design – (IRB/CITI Certificate) Informed Consent Letters…	**Chapter 3** Due CITI Certificate / Draft IRB Application/ Proposal Draft
June	Data Collection Qualtrics	Presentation Marathon Week (Second week in June) IRB Application Submitted
July	Write results of data analysis	**Chapter 4** Due
August	Writing conclusions and recommendations	**Chapter 5** Due
September	Dissertation Refinement Workshop	Final draft of complete document and PowerPoint
October	Dissertation Defense Workshop Apply for Graduation Order Cap and Gown	Dissertation Defense* (Final date for October 2024 per the Graduate School Schedule)
November	Attend Graduate School ETD Workshop	Make final adjustments and upload them to Proquest

Faculty Involvement and Organization

A group of dedicated department faculty members with graduate faculty status volunteered to participate in the program. They thought about what could be preventing students from not completing their dissertation and driving them to drop out of the program. Could it be lack of skills, no knowledge of the process, poor mentoring, or inconsistency of engagement with advisor? Faculty members also discussed which processes worked to ensure completion and which led to hindrances.

Faculty were organized into topic-specific groups to provide targeted expertise and support to students with similar dissertation topics. For example, FacultyA: Instructional leadership and improving student learning: This theme investigates how educational leaders can effectively support and improve teaching and learning in their schools. Researchers in this area study the impact of leadership practices on teacher quality, curriculum development, and instructional innovation. Faculty B's interest was in School culture and climate: This theme explores how educational leaders can create positive and supportive school cultures that promote student learning and well-being. Researchers in this area study the impact of school climate on student achievement, teacher morale, and parent involvement.) Students selected a dissertation chair based on research interests. This structure fostered collaboration among faculty and students, creating a supportive and collaborative learning environment.

Another form of collaboration and networking among students and faculty included a motivational speaker series with a "Mix and Mingle" in collaboration with the Graduate Student Association. These evening events took place on campus and were widely popular. They included topics such as "Believe in Yourself" and "Building Your Dream."

In addition to the ABD Boot Camp, the Graduate School supported Graduate students with a Graduate Writing Center. The Center is free and open to all Tennessee State University Graduate students. It is staffed with Faculty Tutors focused on assisting graduate students with writing projects, theses, and dissertation writing, publications, literature reviews, and much more. With regular office hours and meetings by request, the Writing Center help with APA and Graduate School formatting.

Implications for Leadership

Leadership must begin with analyzing dissertation completion through a quality assurance lens. This begins with identifying the problem. With nearly 100 students at the ABD stage, the first question was "why"? We looked at the factors below to understand the "Why":

- From Students – ABD Student Satisfaction/Completion Survey
- From Students – Advisor Support Survey
- From Faculty – Examine Dissertation completion rates by faculty
- From Faculty – Department meetings/Discussions regarding the *Why*'s for non-completers
- From Topic – Do certain topics (or dissertation types) ensure greater success?

From each of these metrics, we employed program changes and resources that addressed the reported concerns. We continue to reassess and evaluate for the best results. See Figure 3 for a list of concerns and suggested solutions. As each semester passed, we saw higher numbers of students completing their doctoral degrees. Progress monitoring is ongoing and will occur through graduation rates and student satisfaction surveys.

Figure 3. Common Concerns and Suggested Solutions

Concern	Solution
• Lack of psychological and/or community support	• Cohort Groups Time Management/Mental Health Support Learning Assessment
• More Writing Assistance	• Graduate Writing Center Support
• Assistance with research tools	• AI/Research Tools • Professional Development for students and Faculty
• Lack of advisor responsiveness	• Required online weekly dissertation meetings with mentor/dissertation chair
• Lack of ongoing academic support	• Monthly ABD Boot Camp sessions (whole group) Topic-based
• Lack of structure	• Weekly sessions with mentor – Individual meetings (progress reports)

Implications for Reducing Doctoral Attrition

Teachers with the PreK-12 setting typically begin their classes each semester with a Learning Styles Inventory. This tool helps teachers to best align their instructional practices with the students learning styles. This approach identifies the instructional strategy that would help to promote student success. In the doctoral setting, similarly, institutions must identify the environmental and programmatic tools that would best address the needs of their doctoral students as they begin the dissertation process. Factors such as writing support, community, and research assistance can be readily identified based on student surveys, past student performance or the chosen dissertation topic. Then, an individualized or group system of support can be developed for the students.

Also, a series of "courageous conversations" is needed for dissertation advisors. These conversations would include:

- discussions on dissertation completion rates by dissertation chair
- what is an acceptable rate?
- why are some professors rates higher than others?
- how to support professors to encourage student motivation and success
- how to align professors with dissertation topics
- how to maximize your professors' intellectual capacity

In conclusion, doctoral students make considerable progress in a supportive environment (Bueno, 2023). Students supported by mentors and by peers help them to feel a sense of belonging and be successful and guide them throughout the research process. By implementing a structured mentorship program, we have discovered an increase in students' confidence levels. It is just as simple as a system of pairing students with faculty with similar research interests or personality characteristics and meeting together constantly.

Similarly, offering regular progress review sessions scheduled periodically with structured progress reviews to help students stay on track allows the students to feel a sense of community and part of a group. They are able to talk to people just like them and who "understand." Making students accountable

for their work and progress is the key to getting the work done. We found that providing time management and productivity workshops help students to organize their dissertation work.

One great tool is the Gannt chart. The Gantt Chart is a graphical representation of activity against time; it helps project professionals monitor progress. (*What Is a Gantt Chart?—Definition & Examples - APM*). It is comprised of a list of tasks to be performed on the vertical axis and time intervals on the horizontal axis. The Gantt Chart is a tool for project management developed by Henry Gantt in the early 1900s. It uses horizontal bars to show the period of time when each task or resource has been scheduled. It may also show the portion of work completed, task dependencies, milestones, and other data.

Figure 3. An Example of a (Partial) Dissertation Timeline Gantt Chart

	DATES (by week)								
TASKS TO BE COMPLETED	9/8-9/14	9/14-9/21	9/22-9/28	9/29-10/5	10/6-10/12	10/13-19	10/20-26	10/27-11/2	.....
Committee Page									
Preliminary Pages									
CHAPTER 1									
Background									
Statement of Problem									
Purpose of Study									
Research Questions									
Significance of Study									
Theoretical Framework									
Assumptions									
Definitions									
Chapter Summary									
CHAPTER 2									
Introduction to Chapter									
Historical Background									
Subtopics									
Synthesis of Literature									
Chapter Summary									
CHAPTER 3									
Introduction to Chapter									
Research Design									
Population and Sample									
Instrumentation									
Permissions									
Consent Form									
Qualtrics (if applicable)									
Appendices									
Data Collection Process									
Data Analysis Plan									
Ethical Considerations									
CITI Certificate (ethics)									
Proposal Slides									
Date set for Proposal									
IRB Application Filed									
Data Collection Process									
CHAPTER 4									
CONTINUE WITH TASKS									

A vast number of software applications have been developed for project management, and most of these use a Gantt chart to visualize the project schedule. However, if one does not need all the bells and whistles of these applications, a spreadsheet, such as Excel, can be a simple solution. One must know all the individual tasks required to complete the project in order to create a Gantt Chart, in addition to an estimate of how long each task will take and which tasks are dependent on others. The very process of pulling this information together helps a student focus on the essential part of the project and begin to establish a realistic

period for completion. Figure 3 displays an example of a simple (partial) dissertation timeline Gantt Chart made in Microsoft Word.

Another recommendation and most valuable resource would be to provide training for faculty members and students in utilizing various AI (artificial intelligence) tools for constructing their drafts and compiling resources for their literature reviews. Two of the most popular and widely used tools among the ABD Boot Camp participants have been *Claude AI* (claude.ai) and *Elicit* (elicit.org). Both of these resources, at the most basic level, have no cost associated with them. However, if one wants to access more detailed or robust output, a nominal monthly fee is applied.

Claude AI, created by Anthropic, may be used to help a student in drafting and streamlining the first draft of a proposal. It assists into digging into powerful topics and can suggest a possible purpose, significance, background, theoretical framework, research questions, and methodology for a study. However, the quality of what one puts in creates the quality of what comes out. One may continually revise and edit the output by adding additional guiding questions. Nevertheless, the product of the *Claude* search is merely a jumping off point and should never be used as THE actual proposal.

There are several benefits of using *Claude* for dissertation students who are struggling to complete their work. One is breaking through writing blocks and maintaining momentum. *Claude* can help students overcome the paralysis that often comes with large, complex projects. When a student is stuck on a particular section or does not know how to begin, *Claude* can help brainstorm ideas, create detailed outlines, or even help write rough drafts that can refine them. This collaborative approach helps maintain forward progress rather than getting bogged down in perfectionism or overwhelm.

Another benefit of *Claude* is research organization and synthesis support. Dissertations require managing vast amounts of research from multiple sources. *Claude* can help a student organize a literature review, identify gaps in research, synthesize complex information from different studies, and help see connections between various theories and findings. This is particularly valuable when a student is drowning in sources and struggling to create a coherent narrative from research.

A third benefit of using *Claude* is feedback and revision assistance. Unlike human advisors who may have limited availability, *Claude* can provide immediate feedback on a student's writing, helping to identify unclear arguments, suggesting improvements to structure and flow, and aiding to refine academic voice. This constant availability for constructive feedback can be especially helpful during intensive writing periods when a student needs quick input to keep moving forward.

These benefits work best when *Claude* is used as a collaborative tool alongside proper academic supervision. *Claude* must not be used as a replacement for the critical thinking and original analysis that must come from the student as the researcher.

Elicit: The AI Research Assistant (Elicit.com) is another unbelievably valuable AI tool. *Elicit* is an AI research assistant which helps researchers find relevant papers and summarize information, It can automate tasks like literature reviews, systematic reviews, and meta-analyses. For struggling doctoral students, *Elicit*AI transforms the most time-consuming and overwhelming part of

dissertation writing—the literature review—into a manageable, efficient process. This can provide the momentum boost needed to push through to completion, especially for students who have been stuck in the research phase for extended periods. It can find relevant research and search and discover papers. *Elicit* can search a vast database of academic papers, including those from *Semantic Scholar*, to find relevant articles, even if they do not match exact keywords. Additionally, *Elicit* is able to summarize papers and can generate concise summaries of individual papers or groups of papers, highlighting key findings and arguments. *Elicit* can help researchers brainstorm and refine their research questions. The tool is capable of identifying search terms and can suggest relevant search terms and keywords for a given research topic. It can assist in defining terms and concepts used in students' research. It is truly an assistant.

Final Thoughts

We learned many valuable lessons. By providing shared communities with clear milestones, a supportive environment with caring mentors and peers, students will feel a sense of belonging. Additionally, by providing easy, available access to resources, AI tools, and supports, students will feel empowered. The ABD Bootcamp provided all of these and more; students began to flourish. Our goal was to engage students and to motivate and empower them to want to finish their degree in which they had invested so much in emotionally, intellectually, and financially. One student commented that the biggest barrier for her was *herself*. Once she overcame the negativity and procrastination, she was able to produce and "move on" and enjoyed the process.

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B.Ed. Students' Perceptions of Cooperative learning in an English Language Class in South Africa

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The objective of this study was to determine the perceptions and experiences of recently graduated English for Education students at a South African tertiary institution when cooperative learning was employed in two of their modules – one for third-year and one for fourth-year. In addition to this, the study provided insights into how cultural issues shape pedagogical choices. Students were requested to comment on two specific activities, where cooperative learning was implemented – a moot court activity based on JM Coetzee's novel, *Disgrace*, and a panel discussion on various approaches to teaching grammar, specifically within a South African context. This research is underpinned by the social interdependence and socio-cultural theory. Curriculum development was used as an opportunity for professional learning. A qualitative approach with a case study design was used. Data were generated by using a written interview. The findings indicate that students generally perceive cooperative learning in a positive light and as an opportunity to develop their critical thinking skills through interaction in safe social spaces. Cultural differences in the groups influenced what choices students made in terms of cooperative learning.

Keywords: Cooperative learning, B.Ed. students, *Disgrace*, Grammar teaching approaches, moot court and panel discussion

Introduction

Cooperative learning is defined by Bosch et al. (2019) as an approach that involves a small group of students working together, who has a common goal and aims to solve a problem or complete a task. Cooperative learning as a teaching and learning strategy has been well-researched for more than four decades, and its positive effects on students' social and academic achievements have been established (Johnson et al., 2002; Johnson & Johnson, 2009; Mardiani & Hanifah, 2023; Kyndt et al., 2013; Slavin, 1995; Roseth et al., 2008; Tolmie et al., 2010). There are many advantages of cooperative learning, including opportunities for interaction, sharing of ideas, clarifying differences, and constructing new knowledge. Gillies (2006) argues that students are less reluctant to engage in discussions at a more advanced level, tend to interrupt one another less, and provide more intellectual input during cooperative learning than in more traditional classroom settings. Tlhoaele et al. (2014) reiterate that cooperative learning offers opportunities for interaction among students but also mention the development of critical thinking. This is supported by Johnson and Johnson (1999, pp. 72) as they argue that cooperative learning results in "higher-level reasoning" and "more

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frequent generation of new ideas and solutions". Cooperative learning is, unfortunately, often equated with traditional group work, where students are divided into groups and are expected to complete assignments or projects. There are fundamental differences between the two learning strategies, with cooperative learning being more than group work. Hwong et al. (1993) posit that group work in and of itself may not be enough to effect higher achievement in learning. Johnson and Johnson (2002, pp. 95) concur with this sentiment when they maintain that "putting students into groups to learn is not the same thing as structuring cooperation among them". Some drawbacks of traditional learning groups include the individual evaluation of students' performances and free riding. When working in traditional learning groups, students may not be required to pay attention to how groups function, and individual accountability may not be required, whereas in cooperative learning, lecturers need to prepare, plan, and monitor the group work meticulously. Johnson and Johnson (2009) posit that cooperative learning as an approach has been successful, as it is underpinned by sound theoretical foundations.

Despite the fact that cooperative learning activities have many benefits for students, these are not promoted widely in South African schools. The discussions in classrooms are mostly teacher-dominated and directed (Murphy et al., 2020). Teacher-centred pedagogies are compounded by the fact that there are many home languages in one classroom, which results in rote learning (Murphy et al., 2020). Such rote learning inhibits learners' ability of learners to think critically and develop discourse skills. Sikhakhane et al. (2020, pp. 706) share that South Africa's teaching and learning system is "overall marred by traditional model-kind of pedagogy characterized by teacher-centred approaches and its infrastructure of the classroom, the textbook and the assessment strategies". These teacher-centred practices will not change in secondary school classrooms if preservice teachers are not taught how to engage their learners in discussions in classrooms and, more specifically, small group discussions to help learners reach their full potential and contribute to knowledge construction. The research questions that informed this study were: What are B.Ed. students' perceptions of cooperative learning in an English language class in South Africa? How do cultural issues shape pedagogical choices?

The following sections include a literature review, a discussion of the theoretical framework, and an explanation of how the students were prepared for the implementation of cooperative learning. This is followed by a section detailing the methodology used in the study, the results and discussion, and a concluding section.

Literature Review

Theoretical Framework

This research is underpinned by the Social Interdependence Theory, established by Lewin (1949), Deutsch (1949, 1962), as well as the socio-cultural theory of Vygotsky (1978). Many researchers used these theories as a foundation for their research, for example, Gerpott et al. (2018), Shimizu et al. (2020), Alkhudiry (2022),

Dewi and Oktapiani (2022). The work of Barnes (1992) and Mercer (2007) on the value of small group discussions is also relevant to this research. Lewin and Deutch argue that individuals may be dependent on one another through having common goals and that the actions of one individual have an influence on all others. Therefore, it is important to structure cooperative learning opportunities carefully, and Johnson and Johnson (1989) and Johnson et al. (1998) recommend five elements that will assist in ensuring quality cooperative opportunities. These 5 elements are: positive interdependence, individual accountability, face-to-face promotive interaction, social skills, and group processing. The researchers briefly explain these elements in the next section:

- Positive interdependence: The idea that one person is connected to another and can only succeed if they do so. According to researchers in the theory of social interdependence, there are two types of social interdependence: positive and negative social interdependence, such as Deutsche (1949, 1962); Johnson (2003); Johnson and Johnson (1989, 2009). According to Johnson and Johnson (2015, pp. 164), "there is negligible interdependence (i.e., competition) when individuals recognize that they can achieve their goals if and only when other individuals they are competitively linked to cannot achieve their goals", and there is no interdependence (i.e., individual efforts) when individuals recognize that they can achieve their goals, regardless of whether other individuals in the situation achieve or do not achieve their goals".
- Individual accountability: The performance of each student in the group is assessed, and each is held individually accountable.
- Face-to-face promotional interaction: Group members promote one another through help, support, encouragement and praise. Johnson and Johnson (2002) point out that this element explains verbally how problems can be solved, discusses fundamental concepts, concepts learned, teaching students what they have learned, and makes connections between what they have learned in the past and in the present.
- Social skills: Some skills, such as leadership, decision-making, trust building, communication, and conflict management, are necessary for successful cooperation learning (Johnson & Johnson, 1997; Johnson & Johnson, 2014).
- Group processing: This means examining the success of group members in achieving goals during or after the completion of assignments or projects. Johnson and Johnson (2002, pp. 98) conducted a meta-analysis and identified that group processing improves daily and post-instructional performance, retention, motivation, positive relations between students, success in problem-solving and self-esteem, and positive attitudes.

The five elements of cooperative learning discussed above are relevant to the activities that students had to complete and share their perceptions through a questionnaire. However, Vygotsky's (1978) understanding of the social nature of learning also provides a powerful counterpoint to the privileging of individual cognitive development that is a hallmark of traditional educational settings. His

socio-cultural theory is pertinent to this research, as he argues that knowledge is constructed through social interaction among individuals. The social aspect of learning and the importance of group work are echoed by Douglas Barnes. He has provided a rigorous analysis of small group situations and how other individuals (i.e., not just the teacher) can scaffold peers into learning through talk in which they engage. In *Communication to Curriculum* (1992, pp. 14), Barnes argues that what is intended in any curriculum is transformed in classrooms when these intentions reflect "the communicative life of an institution, the talk and gestures by which pupils and teachers exchange meanings". Barnes (1992, pp. 14) continues to say that in order for a curriculum to be meaningful, it has to be "enacted by pupils as well as teachers, all of whom have their private lives outside school". The social skills needed to work in small groups need to be honed and developed. The benefits of small group discussions are mentioned by Barnes et al. (1969, pp. 28) as providing learners space for the "hesitations, uncertainties, rephrasings and false starts which would be impermissible in the 'final draught' talking, in front of the whole class" as "valuable way-stations as students '[are] groping towards a meaning". They further argue that in small group discussions, the "usual source of authority" is removed, and this compels learners to think for themselves. The work of Neil Mercer is heavily indebted to Barnes' work. Mercer's work is explicitly Vygotskian in nature in that he emphasises that language and learning should be conceived as social activities, rather than simply as cognitive processes that occur within individuals' heads. Mercer (2000) advocates for an intermental developmental zone, which is in contrast to Lev Vygotsky's Zone of Proximal Development. This intermental developmental space is a space that language makes possible and where learners interact and develop critical thinking and reasoning skills (Littleton & Howe, 2010). In a more recent chapter, Mercer (2008, pp. 67) maintains that learners "internalise the dialogues they have been involved in as models for their own thinking". He echoes Johnson and Johnson (1989, 2009) when he says that a group "seems to achieve more than the sum of the individual contributions" (Mercer, 2008, pp. 67), reminding one of individual accountability and positive interdependence. Mercer and Littleton (2007) also maintain that classroom talk should encourage exploration rather than being disputational, should encourage cooperation and not competition, with the former focusing on explaining ideas, paying attention to the views of others, and encouraging mutual understanding in contrast to the latter, where disagreement is often the focus.

However, for cooperative learning to be successfully implemented in their own classrooms one day, B.Ed. students need to be adequately prepared in terms of the theoretical background to cooperative learning, approaches to cooperative learning, and various skills needed when implementing cooperative learning. Theoretical knowledge alone will not be sufficient, and students need to design activities themselves, which they can then use in their classrooms once employed as teachers. Abramczyk and Jurkowski (2020, pp. 298) maintain that teachers use cooperative learning less often than traditional approaches, and mention factors such as gaps in teacher knowledge about cooperative learning, as well as their beliefs about the effectiveness of and difficulties implementing this approach, as contributing to a reluctance to implement cooperative learning. It is important to

keep in mind that culture and other aspects influence how learners prefer to learn and engage with content. For this reason, teachers need to take cognisance of learning style preferences, values, and socioeconomic aspects when choosing pedagogical strategies. Some cultures may prefer rote learning, while others prioritise critical thinking; some have access to technology, while others do not.

Preparation of Students for the Implementation of Cooperative Learning

Students were introduced to various methods and approaches of teaching from their first year of this B.Ed. qualification at a tertiary institution in South Africa. These include the Grammar-translation, Direct-, and Audio-lingual methods, Suggestopedia, Community Language Learning, Total Physical Response, The Silent way, the Communicative approach, Task and text-based language learning, as well as Cooperative learning. However, many of these are outdated and not utilised today, and the latter three approaches were emphasised in this B.Ed. programme. A balance between theory and practice was maintained by providing the theoretical background to the approaches as well as opportunities for students to apply these in their preparation of lessons. As this article concerns the perceptions of recently-graduated students about cooperative learning, we will focus on how they were prepared to apply this approach.

The researchers, firstly, distinguished between collaborative and cooperative learning, with the latter being more structured. The students, then, did their own research and reported back on this. In small group discussions, they suggested what the common goals of cooperative learning are. Once students had a basic grasp of the approach, a more theoretical session ensued where the five elements of cooperative learning (Johnson et al., 1998) were taught with input from the students. A whole group discussion on the difference between a traditional and cooperative classroom situation provided further theoretical knowledge to students. This was followed by a description of the pitfalls of cooperative learning. Thereafter, students were given an assignment utilising one of their prescribed novels, *Disgrace,* by J.M. Coetzee (1999). The assignment entailed preparation for a mock trial (i.e., a drama) at the actual moot court, and students were placed in groups of eight. The students needed to be familiar with the plot of the novel to conduct a proper trial. This was a summative assessment after an in-depth look at the philosophical concept of "the other" and existentialism as these manifest in the novel, characterisation, major themes, and symbols, and how these contribute to the message of the novel. Thorough preparation and research needed to be done before the trial date. General information was given with regard to the roles, procedures, and terminology used in a court of law. The case to be argued was whether David Lurie was guilty of rape after having been accused by the character of Melanie Isaacs. This opportunity allowed for the development of skills, such as critical thinking, collaboration, communication, and creativity. The outcome of the trial was not the most important issue, but rather the skills learned and the opportunity to collaborate. There were eight roles from which group members could choose from: Judge; counsel for the prosecution; counsel for the defence; defendant (David Lurie); complainant (Melanie Isaacs); witness for the prosecution (former student of David Lurie);

witness for the defence (neighbour or colleague of Lurie); usher and clerk of the court. The groups were heterogeneous, with both male and female students. The rationale for this was that certain roles were more demanding and complex than others, thus providing opportunities to students who had stronger and weaker proficiency levels when choosing roles. Role definitions and role guides were discussed with students, examples of opening and closing statements, cross-examination examples, a glossary of terminology, as well as the general procedure in a court were provided. Two groups, who had differing opinions concerning the guilt of David Lurie, were evaluated at a time, while arguing their cases in front of a panel of lecturers. Moges (2019) argues that students have particular roles to play when doing group work, and all members have a shared responsibility to find solutions collaboratively. The criteria for assessment of each role were clearly stated in the rubric provided to students before the activity, e.g., the judge: are they familiar with the case, do they manage the trial effectively, and do they maintain an authoritative presence? The students also received a mark for overall group work in terms of teamwork, overall performance, and whether the trial flowed.

The second assignment that required students to employ cooperative learning was after a unit on how to teach grammar. As this is a contentious issue, students explored various points of view, such as a focus-on-form, focus-on-forms and focus-on-meaning approaches, as well as a balanced view on teaching grammar by taking into account the unique South African context. Unique implies that many learners take English as a home language, when in fact English is a first, second, or maybe third additional language. Students also designed activities with a focus on accuracy and meaning before the summative assessment of an online panel discussion. In groups of 5–6, students had to organise a panel discussion about grammar teaching and the different approaches advocated. This was a culmination of the knowledge that students had gathered through reading articles by experts in the field, class discussions, and having designed the activities with a focus on accuracy and fluency. Roles were once again suggested, but students could choose these among themselves. Each group had a moderator, and the rest of the group members were panellists advocating for an approach or a combination of approaches. The moderator was not a panellist and played a different role, and their ability to control the event was important. The panel members had to state their point of view and argue from an empirical point of view by referring to research. Criteria that were assessed for individual students were: content knowledge, ability to persuade the audience, and academic use of language; and for the whole group: preparation and appeal to the audience. The next section elaborates on the methodology followed for this research.

Methodology

This research is based on a qualitative approach with an interpretivist paradigm and a case study design. This paradigm served as a lens to explore how recently-graduated students perceive cooperative learning, and how they construct their social world (Nieuwenhuis, 2007). The students were purposefully selected and had to adhere to criteria: 1) recently-graduated B.Ed. students from one tertiary institution

and 2) currently teaching English at a school. All recently-graduated students were invited to participate. The possible sample size was 40. Eight students agreed to participate, nine pursued further studies and could not be included, ten were not employed as teachers, and the rest declined to participate. The experiences of the eight students who participated are the case in this research. The written interviews were sent to the students by email to explore their perceptions of cooperative learning in an English class. The trustworthiness strategies suggested by Denscombe (2018) were used for this research: credibility, dependability, transferability and confirmability. Students were asked to review summaries of their written interviews (i.e., credibility), the researchers kept a detailed audit trail of the research (i.e., dependability), provided thick descriptions of the research for other researchers to judge the relevance to their own research or contexts (i.e., transferability), and shared verbatim words of students (i.e., confirmability). The following questions were posed to the participants:

1. Comment on the two specific cooperative learning opportunities from the modules ENGV 311 and ENGV 421, respectively, and say how successful you think these were in terms of execution and knowledge acquisition.
2. What did you appreciate/enjoy and what did you not appreciate or enjoy about these cooperative learning opportunities?
3. Explain how you organised yourself in your groups in terms of leadership, role division, communication and preparation.
4. Which forms of technology were used to communicate with your group members, and how effective were these?
5. What difficulties did you experience as an individual and as a group in general, and how did you deal with these?
6. Comment on the value and effectiveness of cooperative learning opportunities compared to more traditional learning opportunities.
7. Do you believe that the two respective cooperative learning opportunities adhered to the principles of: positive interdependence, individual accountability, promotive interaction (appropriate use of social skills), and group processing? Please elaborate.
8. How possible and how likely is it for you to implement cooperative learning at school level? Please elaborate.

Results and Discussion

After analysing the data thematically, the following themes emerged: Deeper understanding of the content, learning from one another, online challenges, group dynamics, communication platforms, and future implementation. In the next section, we provide the responses of the students and short discussions on these results.

Deeper Understanding of the Content

Students mentioned the following, which indicated their perceptions that cooperative learning provides opportunities for alternative and effective entry into texts. These are some of the students 'responses.

> "I gained a better understanding of the novel."
> "… we were able to step into the characters of the story and imagine their interaction as it would have happened in the novel."
> "The opportunity to interact with the novel and physically put it into play made me understand it better. I did not understand what people meant when they said it is better to meet theory with practice, but now I know it is a better way to retain information."
> "It really helped to acquire knowledge about the book and understand the book better. We had the opportunity to talk about issues such as rape and violence against women."
> "The moot court was initially met with resistance and a sense of anxiety. Many of us were worried whether we would successfully complete the task and what relevance it had to the module or novel…however, once we were made to understand what was expected from us…it proved to be more fun than stressful"
> "When theory is met with practice, I retain information better."
> "As a whole, I would say that this cooperative learning opportunity was a success."

Students overwhelmingly felt that cooperative learning provides an opportunity to understand content better and to enhance knowledge acquisition. The two cooperative assignments allowed them to immerse themselves deeper into the complexities of the novel, *Disgrace*, by J.M. Coetzee (1999), and to understand the different approaches to grammar teaching. Meaning is negotiated when students work collaboratively. Yandell (2020, pp. 16) argues that literary texts open up possibilities of learning, development, and semiotic work. He continues to say that these possibilities are not necessarily inherent in the texts themselves – in their literary qualities, say – but rather that the possibilities arise out of the kinds of engagement with the text (Yandel, 2020). This is echoed by Doecke and Mead (2018, pp. 252), whose essay prompts the role that literary knowledge plays in the subject, English. The researchers maintain that to "read a text" is to engage in a process of making meaning through interaction with others, and the "social exchanges that occur within classroom settings are not simply incidental or instrumental to this process but the necessary conditions for meaning making to occur at all." Preparing a moot court activity based on a novel or a panel discussion on different grammar approaches is very different from just answering a set of questions based on the content. The comment that the cooperative moot court activity enhanced understanding of the novel points to an opportunity to explore issues such as social justice, equity, and diversity in the text. Students may explore how characters and cultures are represented, which in *Disgrace* varies from being dominant to marginalised. The moot court activity is a different pedagogical strategy for dealing with a sensitive issue, such as rape and violence against women. South Africa has sadly been dubbed the rape capital of the world. It is

mentioned in the South Coast Herald (2018) that South Africa is known for high rape statistics but refers to being dubbed the rape capital of the world as arbitrary.

The students also mentioned the ability to gain a deeper understanding of the content in terms of the various grammar approaches:

> "… since the discussion with peers who were more knowledgeable others in a specific topic helped us all to understand the different concepts much better."
> "I for one was struggling a bit to make sense of the perspectives from the articles… but when I did more research, and started to make my own notes, I could connect the dots and the light bulb went on."

The students felt that the panel discussion afforded them the opportunity to learn in ways different from the traditional way of learning. They had to become experts in different approaches to grammar teaching and had to share this knowledge as panellists. Doing their own research also assisted them in becoming more knowledgeable about diverse viewpoints.

Students may bring diverse cultural lenses when they collaborate and design activities (like a moot court or a panel discussion). They seem to regard cooperative learning as a pedagogical strategy that values multiple perspectives. The next theme is related to the theme of gaining a deeper understanding of the content.

Learning from One Another

Students commented the following on how cooperative learning provides opportunities for learning from one another by exchanging ideas and engaging in discussions:

> "… it gave you the opportunities to share knowledge with each other and also to learn from each other."
> "The panel discussion felt as if we were teaching each other, because we shared our understanding of the terms and got a chance to ask questions."
> The students indicated that they enjoyed the opportunity to collaborate and learn from each other, as well as the learning of a new approach that they can employ in their own classrooms. Students commented:
> "We learned new methods which we can implement in future literature or language classes."
> "… we had fun and learnt a lot from each other."
> "Everyone got a fair chance to teach one another about what they learned concerning their section."
> "I enjoyed the collaboration and with other students and being able to learn from them and being able to change or shape one's own viewpoints based on what you can learn from others."
> "I was able to build great friendships."

When employing cooperative learning, every member of the group should be responsible for a concept/idea and then explain that to the rest of the group. This ensures that everyone learns something. Research has proven that when students

explain concepts/ideas, it has a positive effect on understanding and cognitive development (Jacob et al., 2020; Kobayashi, 2019; Wellman & Liu, 2007). The feeling of being an expert on a topic also enhances self-confidence. The benefits of learning in social contexts became apparent, and students seemed open to new ways of teaching and learning.

Cooperative learning does not come without its challenges and especially so when implemented in contexts that may not be conducive to the approach.

Online and Other Challenges

Students commented on what hampered the implementation of cooperative learning: The following quotations refer specifically to the panel discussion on grammar teaching approaches:

> "… we had the problem of doing it online which I know was a struggle for everyone and we would have loved to be in class, but we did try to make the best of it."
> "… This activity was different from the above-mentioned [moot court] as we never came together physically. We still needed each other's work to complete the task and we were therefore held accountable for our own work to ensure the success of the group work."
> "The panel discussion was not easy for me to understand or implement."
> "I missed the variety of scaffolding activities in this task."
> "It was hard not to be physically able to work with students."
> "I didn't enjoy all the research that we had to put into the task."
> "I enjoyed the research part of the activity and expanding my own knowledge in my own way."

The panel discussion activity was executed online and students found this activity generally more difficult, and it seems as if the online mode contributed to this. However, the fact that the scaffolding was mostly self-directed could also have contributed to students experiencing this activity as more difficult. Their feedback was valuable in terms of how to provide additional scaffolding in the future. The reading of the academic articles on the different approaches to grammar teaching was daunting to the students, and this may have to be approached differently for future endeavours. There were contradictory feelings regarding the research, as some students enjoyed the academic articles, while others did not. Jacob et al. (2020, pp. 7) in a study conducted on students explaining concepts to one another found that "the effect of explaining modality depends on the level of linguistic text complexity of the studying material". The more complex the text, the more difficult students find it to explain concepts from the text to others. However, students explaining orally outperformed those who explained in written form (Jacob et al., 2020).

It is clear from responses that participants learned from one another by becoming experts on a specific approach and then sharing ideas with one another. Their preference for face-to-face contact was clear in their feedback. This is an aspect that may need attention, as teaching globally is moving more toward hybrid modes.

Group Dynamics

This theme is related to social skills and group processing as necessary elements for cooperative learning as suggested by Johnson et al. (1998).

Students commented as follows:

> "When we organised ourselves with the moot court, we decided that we would all get together and chose the roles that we think will work for everyone."
> "This meant we partner with students whom we knew are diligent, would come prepared and takes responsibility for his/her own section of the assignment."
> "What I did not enjoy was when I was unable to choose who I wanted in my group."
> "In the moot court activity, we did not have to appoint a leader per se, since we valued each other's opinions equally. We decided as a group, who would be best suited to portray each character."
> "We actually just chose roles…we would look at each other's characters and decide as a group that this role would suit this one."
> "We also decided that the one with the strongest personality would take on the role of group leader, while the person who is always on time and organised, will take on the role of communicator."
> "Leadership was usually given to the person that had the most knowledge."
> "… frustration came in when other students did not do his/her part or did not meet deadlines. This meant that I had to alter my own planning for my studies."
> "Our biggest problem during the moot court project was making sure that everyone produced quality work on time. Many thought that it would be easy to sponge off of the work of the others."
> "… the difficulties we experienced was finding suitable dates and the time to have Zoom meetings."

Gilles and Boyle (2010) comment that it is not that easy to construct groups to work well together. The students indicated that they preferred to choose their own groups. There is generally no consensus on whether heterogeneous or homogeneous grouping is more effective for student learning. A study conducted by Baer (2003) found that college professors usually place students in groups on a heterogeneous basis, but that homogeneous grouping in their specific study resulted in better achievement than the heterogeneous grouping. As far as role division is concerned, it appears as if this occurred without any challenges. Students assigned the more difficult roles to the academically stronger students; however, personalities were also taken into account, as both of these activities required students to perform. The online activity seems to have required more control from appointed leaders. Kaasila and Lauriala (2010, pp. 855) comment that group members develop expectations on the basis of their own "status characteristics" and that an individual's status characteristic is associated with a belief of how this individual is expected to perform. The weight given to an individual member is determined by their status. The "higher the status and role of an individual" (Kaasila & Lauriala, 2010, pp. 855), the more is expected of them in terms of contribution. It appears as if the appointment of leaders and roles happened naturally, with students knowing the abilities and personalities of their fellow group members.

Premo et al. (2018, pp. 1) confirm Johnson and Johnson's (1999) sentiment that simply being paced in groups does not guarantee effective cooperation by stating that "unstructured groups may have negative interpersonal effects, including decreased motivation". Participants seemed to have one common problem, which relates to free-riding, as some students were unmotivated. A strategy to mitigate the effect of unmotivated students, suggested by students, was to divide the task into smaller chunks so that everyone was responsible for a critical part of the task, ensuring accountability. Time was also a huge factor in the sense that students struggled to find a time to suit all the members to get together either physically or in an online mode. Abramczyk and Jurkowski (2020) found in their study that teachers wanted to incorporate cooperative learning in their teaching but experienced constraints in terms of time. Mardiani and Hanifac (2023) agree that teachers, who want to include cooperative learning through the means of drama, might not have the necessary time to do so if they only rely on allocated formal teaching hours.

When asked whether the activities the students completed adhered to the principles of positive interdependence, individual accountability, promotive interaction (appropriate use of social skills), and group processing, participants seemed to agree that they did. They had this to say:

> "The group as a whole was aware that in order to achieve, each member had to do his/her best."
> "The students challenged each other and managed to make each other see different points of view and together found ways to justify their new opinions."
> "… everyone was forced to do their absolute best in their preparation and execution to prevent failure in the larger group."
> "Members were also actively participating as they were aware that practice and discussions were needed in order to produce a good end product."
> Only a few participants mentioned aspects related to group processing:
> "… we provided feedback to one another after our trial runs to ensure that everybody was happy with the flow of the panel discussion and where we felt we could improve."
> "If a student is uncertain on the content other students will provide guidance… were always discussed and planned for together and if I was moving in a wrong direction, the other students always offered guidance and vice versa."
> "Students had to support each other continuously to better their product."
> "… we brainstormed ideas together to think of our way forward, then revised that as a group when we started practising if we saw places where we could perhaps implement changes to the initial plan."
> "With cooperative learning learners do not just learn the material but other skills as well that will help them later in life. Skills such as interdependence, where they learn that they can succeed together, and they have positive interactions with each other. Each student learns to accept their responsibility and develop their own accountability for their part."

Participants genuinely seemed to value cooperative learning, and the most common reasons are the opportunities afforded to work together and to learn from one another. They specifically mentioned that individual work isolates students.

One participant also mentioned that cooperative learning promotes intellectual growth. The participants also relayed their own experiences in classrooms.

From the above statements of students, it seems as if the theoretical preparation on cooperative learning and the practical implementation of the approach in their classes helped them to gain a better understanding of the approach.

Communication Platforms

This theme has more to do with technical aspects than content. Students commented as follows:

The preferred way to communicate was by far WhatsApp groups, followed by Zoom and Google docs. WhatsApp, being a relatively cheap option, is understandable, especially when considering the high poverty levels in South Africa. Zimba et al. (2021, pp. 264) mention that factors such as: "poor access, distant geographical locations, the low socio-economic status of students, and training and support of students and staff of an inadequate quality" limit student participation in online environments in South Africa. Connection issues hampered online performances in some instances. Participants commented:

> "These [Zoom and WhatsApp] were extremely effective as if anyone had any questions regarding clarifications on their assigned topic, we could ask one another on the group and get almost an immediate response."
> "We would always start with a plenary Zoom session,"
> "Additionally, we used Zoom and emails for meetings and documents that we needed to send to each other."
> "This [WhatsApp] worked effectively because it ensured that everyone was informed at all times."

The students' preference for tools like WhatsApp and Zoom suggests concerns of equity. It was important to the students that all had access to information and the sharing of ideas. This shows that pedagogical choices do not only point to learning preferences but also to aspects such as access and inclusion, which can be shaped by cultural and economic limitations. Students' responses indicate that the choice of technologies was motivated by what was possible and not necessarily ideal. These platforms reflect cultural pragmatism, where students adapt to what works best in their cultural and socio-economic circumstances.

Future Implementation

It was important for me to measure whether students would use cooperative learning as an approach in their classrooms because, of course, it is the goal of preparing them to understand and implement it. Students commented the following on the possibility of employing cooperative learning in their classrooms:

> "Traditional learning has lost its effectiveness; learners lose interest and the motivation to learn and I've experienced myself as a student."

> "The only problem a teacher might face in the school is that the classroom sizes might be too big to do such an activity and to be able to manage and control the learners would be impossible."
> "It is less likely that I will implement cooperative learning at this current point in time… the virtual option is also difficult seeing as many learners do not have the technology available."
> "I would love being able to implement these methods in my own classroom, however, I feel that time constraints work against us at times."
> "… I think if not done correctly, it can result in teachers especially in public schools wasting time."
> "I think for me personally I will definitely try and implement cooperative learning in my lessons as the end result is worth all the hassle especially when the learners are really enjoying it and actually learning something."

Participants' responses to whether they will employ cooperative learning in their own classrooms were mostly promising. Meisner and McKenzie (2023) explicitly state that "Teaching in an online setting must become a regular and embedded part of preparation programs including learning management systems, planning, assessment, and delivery that are unique to the online setting" – cooperative learning can better prepare preservice teachers to teach and learn in online settings.

The participants did, however, also mention certain constraints, like class sizes and the difficulty of employing cooperative learning in an online setting. The difficulties of conducting online classes have to do with unequal access to technology, which affects most students in a South African context. Some participants observed that teachers need to be thoroughly prepared to implement this and that proper structure must be provided to learners before implementing cooperative learning. It is uncertain what the one student means by "hassle" with cooperative learning. It may be the effort expected from teachers in terms of planning and designing cooperative learning activities, or it may be a reference to the effort for the learners.

From the above statements of the students, it seems as if the theoretical preparation of cooperative learning and the practical implementation of the approach in their classes helped them gain a better understanding of the approach. Students are eager to implement cooperative learning. However, it remains to be seen if this will realise in their own classes. A more longitudinal study may provide an answer to that. Oftentimes, schools' instructional policy can be very prescriptive in terms of implementing certain pedagogical strategies and may not be open to include more innovative approaches to teaching and learning, even if teachers or students want to use these more innovative approaches.

Conclusions

The over-all feeling is that participants perceive cooperative learning as valuable and that it leads to a better understanding of literary texts or grammar teaching approaches. Participants indicated that they preferred cooperative learning to the more traditional way of teaching, where students are passive

recipients of knowledge. The online panel discussion proved to be more challenging, and it appears that better scaffolding should be provided in order for students to feel more confident to complete this activity. Participants seem to all prefer to choose their own groups and to work with students they are familiar with and with whom they have collaborated before. The idea of positive interdependence and individual accountability was strongly emphasised as elements of cooperative learning that participants kept in mind while working together. The responses of the students confirmed that culture shapes pedagogical choices. The results indicate how the students emphasise the value of collaborating in social contexts while being inclusive, focusing on equity and pragmatism. Some limitations of the study were the small sample, and therefore, no generalisations could be made to a larger population. Another limitation is that the data generation instruments could include observation of newly-graduated students in classrooms to see how teachers employ cooperative learning. It is hoped that students will, in fact, employ cooperative learning after having been exposed to these themselves and having reflected on these accordingly.

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Four Dimensions of Doctoral Expertise: Graduates' Reflections on Learning During Doctoral Studies

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There is an increasing need for advanced expertise in the world to solve complex problems. A high level of education equips both individuals and societies with the expertise required to find solutions. This article examines the nature of expertise developed during doctoral education. The research question is: What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates? The qualitative data consists of in-depth interviews with nine PhD holders. The data was analysed using an inductive approach. According to the results, theoretical expertise was perceived as the strongest and most self-evident dimension of doctoral education. However, practical, self-regulatory, and socio-cultural dimensions of expertise also emerged as key aspects of doctoral expertise. In particular, competence in networking, project work, and internationalisation were identified as crucial skills within the academic field. Nevertheless, flexibility, hybrid expertise, and broad applicability were recognised as core features of expertise regardless of the field. The study suggests that doctoral studies foster diverse and still largely unrecognised forms of expertise. This differentiated expertise should be more consciously integrated into the doctoral process. Doctoral expertise evolves at the intersections of different contexts, across disciplinary boundaries. Espousing an augmented meta-level awareness of the dimensions and processes of expertise, and engaging in dialogue across different fields, benefits doctoral graduates, doctoral education, and society at large in the development and utilisation of expertise.

Keywords: doctoral education, PhD graduate, academia, university, expertise

Introduction

In Europe, efforts have been made to harmonise and structure doctoral education, while simultaneously aiming to improve the quality of its complementary research activities (Aittola, 2017; Cardoso, 2024). In Finland too, doctoral education has been developed since the 1990s to become more systematic, and doctoral students have increasingly been included in this development process (Aittola, 2017). However, further progress is still needed—for instance, in recognising how doctoral graduates build their careers (Maunula, 2023; Piironen et al., 2025). From 2024 to 2027, Finland is running an educational pilot in which 1,000 doctoral candidates have been enrolled into universities for three years with dedicated government funding (Ministry of Education and Culture, 2023). This pilot scheme aims to develop more efficient and flexible practices in doctoral training.

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Significantly, the number of doctoral graduates in OECD countries has doubled over the past two decades, and this trend is accelerating (OECD, 2021). In 2019, the average proportion of 25–64-year-olds holding a doctoral degree in OECD countries was approximately 1% (OECD, 2019), and if the trend continues, 2.3% of today's young adults will enter doctoral education (Sarrico, 2022). Globally, doctoral education is facing growing expectations: the knowledge economy, economic growth, and innovation (Cardoso, 2024; Halse & Mowbray, 2011). Doctoral education is expected to efficiently produce an increasingly refined pool of experts with the knowledge, skills, and future-oriented visions required in the digital and global era (McKenna & van Schalkwyk, 2023). At the same time, general understanding of the capabilities of doctoral holders remains limited (Sarrico, 2022), including among doctoral holders themselves, who often lack awareness of the diversity of the doctoral experience (Piironen et al., 2025). This can be seen as an ethical issue within doctoral education (Cardoso, 2024; Roos et al., 2021).

The employment of doctoral graduates across the wider segments of society has become more common, with over half of doctoral holders in OECD countries now working outside academia (OECD, 2015). Often, those working outside academia report that their research skills have been developed to an extent that exceeds the demands of their jobs, while their personal efficiency, leadership, and communication skills fall short of what is needed (Waaijer et al., 2017). As such, they may apparently be both overqualified and underqualified relative to the expectations of various employment sectors (Sarrico, 2022). Given that doctoral education, cannot always be expected to prepare graduates for every type of work (Sarrico, 2022); therefore employers too must equally take responsibility for continuous and sustainable training of their workforce, for example through appropriate coaching, supervision, and mentorship (Cappelli, 2015; Maunula et al., 2024).

The contexts of doctoral graduates vary between countries at systemic, institutional, and individual levels. Labour markets, academic disciplines, and personal circumstances all shape individual career trajectories (Sarrico, 2022). This article focuses on Finnish doctoral education and the experiences of newly graduated or soon-to-graduate PhDs regarding the dimensions of their expertise. Finnish doctoral education has evolved systematically in line with global trends, with an emphasis on increasing efficiency, improving quality, enhancing internationalisation, and the preparation of professional researchers (Ministry of Education and Culture, 2023). These developments have influenced the various actors, practices, and values across the levels of doctoral education (Jauhiainen & Nori, 2017; Piironen et al., 2025). Discussions have also emerged regarding academic knowledge capitalism and its relevance (Hannukainen & Brunila, 2017). On the basis of this given context, the research question of this study could be formulated and posed as: What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates? This article proceeds by presenting previous research on doctoral education and expertise contextually, followed by a description of the study's methodological options, findings, and then the analytical discussion.

Literature Review

Doctoral education has undergone significant transformation in recent decades, shaped by both global policy agendas and changing expectations of doctoral graduates. In response to societal demands for innovation, interdisciplinarity, and employability, the purpose and structure of doctoral training have expanded beyond traditional academic pathways. This literature review explores prior research on the reform of doctoral education, the evolving expectations placed on doctoral candidates, and the theoretical understanding of expertise as a dynamic, multi-dimensional process. These perspectives form the conceptual foundation and framework for analysing how doctoral expertise is constructed across diverse contexts.

Reforming Doctoral Education

Doctoral education in Europe is subject to high expectations, and the number of PhD scholars being trained continues to grow (Cardoso, 2024; OECD, 2015; 2019; 2021; 2023). At the same time, the criteria for admission into doctoral programmes have become more stringent, with a clearer emphasis on the quality, relevance and feasibility of the research plan, as well as the applicant's demonstrated research skills and activity (Jauhiainen & Nori, 2017). However, higher education systems have been criticised for their weak connexion with the labour market (Roos et al., 2021; Sarrico, 2022), and there is a global call for doctoral education to become more practical, innovative, and connected to the contextually prevailing real-world challenges (e.g. Costley & Lester, 2012). Thune (2009) highlights the importance of shared objectives and ongoing interaction between universities, public authorities, and industry. A bold reorganisation of doctoral education, including broader skills applicable to diverse contexts, is seen as an opportunity amid the transformation of knowledge and work settings (Sarrico, 2022). Already twenty-five (25) years ago, Etzkowitz et al. (2000) argued that doctoral education should focus more on employability, entrepreneurial activities, and collaborative capacities extending beyond academia. Today, such themes are increasingly integrated into traditional doctoral programmes to better align PhD expertise with societal expectations.

At the European continental level, higher education has been harmonised through initiatives such as the Bologna Process and the Lisbon Strategy (Bitusikova, 2009). Nonetheless, international comparisons continue to show country-specific features of the doctoral experience (Auriol, 2007; Sarrico, 2022). From the perspective of European universities, intensified financial pressures and competition are central themes (Enders, 2005; Hannukainen & Brunila, 2017). The doctoral training system is continuously streamlined, with only the most promising candidates being admitted and emphasis placed on supervision, international networking, and funding acquisition skills (Jauhiainen & Nori, 2017). Universities now aim to efficiently produce not only doctoral degrees (e.g. Hannukainen & Brunila, 2017), but also multi-skilled academic researchers and innovative experts attuned to the needs of working life (Gu et al., 2018), especially those capable of engaging in dialogue across different domains (Laalo et al., 2019). Despite this, universities commonly assume that graduates will

pursue academic careers, resulting in insufficient preparation for non-academic pathways (Gardner & Doore, 2020; Jaksztat & Gross, 2024).

As part of the Salzburg Process initiated by the European University Association and the ongoing reform of doctoral education, universities have begun incorporating transferable skills into their doctoral programmes. The goal is to better prepare doctoral candidates for career options outside the academia (Hasgall et al., 2019; Hasgall & Paneoasu, 2022). This reform is significant, as only 32% of doctoral students reported having studied transferable skills during their PhD training (Janger et al., 2020). Supervisors play a key role in presenting various career options, pathways and opportunities (Goldan et al., 2023; Gu et al., 2018). The diversification of doctoral careers can be seen as an opportunity to revise doctoral training and supervision to better reflect new realities (Coates et al., 2020). Transitioning from academia to non-academic work is not always easy, and the cultural differences between institutions can even be a psychogenic shock for some doctoral graduates (Skakni et al., 2021). Piironen et al. (2025) identify how doctoral career paths begin to diverge already during the PhD process and highlight the importance of recognising the individual and systemic boundary conditions shaping these trajectories. Recognising such conditions makes the covert practices of academia more visible and open to development, while enriching the discourse on the doctoral researcher's roles and remits.

Doctoral Education and Expertise Development as a Process

The process of earning a doctorate fosters the development of multiple areas of expertise, both domain-specific and general professional skills. Expertise is multidimensional and evolves through a process (Ericsson et al., 2006; Hakkarainen et al., 2004). These authors define expertise as a mode of practice that consistently produces high-level performance. It entails a dynamic attitude aimed at continual improvement in increasingly complex tasks. Chi et al. (1988) emphasise that expert knowledge integrates seamlessly with existing mental models, thereby reinforcing overall understanding. Bereiter (2002) adds that experts flexibly utilise both formal and informal knowledge, including experiential, intuitive, and self-regulatory dimensions.

A widely accepted view holds that expertise comprises four core dimensions: theoretical, practical and experiential, self-regulatory, and socio-cultural knowledge (Bereiter, 2002; Erault, 2004; Ericsson et al., 2006; Lehtinen et al., 2012; Tynjälä, 2010). Theoretical knowledge can be expressed in text or speech. Practical knowledge is developed through undertaking and experiencing and includes both skills and embedded knowledge. Often tacit, this kind of knowledge is linked to various processes but can be made explicit through reflection. Such reflection gives rise to self-regulatory knowledge, which includes metacognitive and reflective awareness of one’s own work habits, idiosyncrasies, thinking, and learning. When reflection extends beyond the self, expertise becomes situated in broader contexts such as one's professional community. Lehtinen et al. (2012) stress that socio-cultural expertise includes implicit rules, norms, and cultural knowledge, which can only be accessed through participation in community practices. The shift from individual to collective expertise is gaining pace (Lindén & Annala, 2016). In

expert performance, the various components of knowledge merge into a seamless and meaningful whole.

While the components of expertise are presented separately—into theoretical, practical, self-regulatory, and socio-cultural domains—they are in fact deeply interconnected in high-level expertise domains (Bereiter, 2002; Tynjälä, 2008). Earlier understandings of expertise focused on individual cognitive processes such as exceptional abilities in acquiring and processing information. However, this perspective has expanded to include participation and identity development, highlighting the evolving process of expertise and the creation of new knowledge. The development of new practices and innovative knowledge communities relies heavily on the interactive growth of individuals and communities (Hakkarainen et al., 2004).

The development of expertise during doctoral studies requires conscious awareness of these dimensions and their integration (Tynjälä, 2010). Hancock (2019) stresses the importance of early-stage doctoral supervision that recognises the different skill requirements for different career pathways. Doctoral researchers increasingly expect career guidance to reflect broader, non-academic career landscapes and to support the development of versatile expertise (Gu et al., 2018). Expertise thus entails not only mastery of disciplinary practices but also innovation and the ability to adapt and anticipate within changing conditions and circumstances (Ericsson & Pool, 2016; Hakkarainen et al., 2004).

Methodology

This article explores the capital of expertise developed during doctoral education, as experienced by recent doctoral graduates and current doctoral candidates. The research question is: *What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates?*

The participants (N=9) were recently graduated or soon-to-graduate doctoral researchers. They were interviewed about their experiences of doctoral education and the expertise they felt had emerged during their doctoral journey. For the sake of simplicity, they are referred to throughout this article as doctoral graduates without further qualification.

The data were collected through thematic interviews, with broad themes covering the entire trajectory of their academic and professional lives—doctoral studies, career development, and the formation of expertise. The interviews lasted approximately 60 to 90 minutes. All were audio-recorded and transcribed. The material is confidential and personal and offers a nuanced view of academic practices and doctoral expertise. Participants were affiliated with three different Finnish universities and represented a range of disciplines, including social sciences, education, economics, sport sciences, social policy, psychology, and mathematics.

To answer the research question, the analysis began with a hermeneutic approach, where the researchers first familiarised themselves with the data and engaged in dialogue using researcher triangulation (e.g., Patton, 2002). This was followed by a theory-driven thematic content analysis guided by the four dimensions of expertise: theoretical, practical, self-regulatory, and socio-cultural expertise

(Ericsson et al., 2006). This approach supposedly allows researchers to draw reproducible and valid inferences from the data in relation to their contextual meanings (Patton, 2002). The process entailed a hermeneutic dialogue between researchers, theory, and data, and through abductive reasoning, an overarching understanding was formed. The research material was in the Finnish Language; only the quotations presented in the results section were translated into English.

The validity of this qualitative study is supported through triangulation and critical reflection by the researchers throughout the research process. The article clearly outlines the study's starting points and contextual framework, enabling readers to interpret its significance appropriately. The dataset is extensive and typical in scale for qualitative research. A critical reader was invited to independently interpret the material and reflect on its implications relative to the study's aims.

Limitations of the Study

As with all qualitative research, this study is context-specific and based on the experiences of a relatively small group of participants (N=9) from Finnish universities. While the sample was diverse in terms of disciplines and institutional backgrounds, the findings cannot be generalised to all doctoral graduates or national contexts. The focus on recently completed or nearly completed doctoral candidates may also exclude insights from those who left doctoral education early or who have accumulated further expertise in later career stages. Additionally, the interviews relied on self-reported reflections, which may be biased or shaped by individual perceptions, memory, imaginations, and context. Another limitation concerns the lack of systematic comparison between disciplines or institutional policies, which may influence doctoral experiences and opportunities for expertise development. Despite these limitations, the study could provide valuable insights into the multi-dimensional nature of doctoral expertise and highlights important areas for further research and development within doctoral education.

Findings – Four Dimensions of Doctoral Expertise

This section presents the key findings of the study, which explores how doctoral expertise is experienced and constructed during doctoral education. Based on the analysis, four main dimensions of expertise emerged: theoretical, practical, self-regulatory, and sociocultural. These dimensions reflect the complex and evolving nature of expertise as perceived by the doctoral graduates. Each dimension is discussed in detail below, illustrated with participants' own reflections.

Theoretical Expertise

According to the doctoral graduates, the expertise developed during their doctoral studies consisted of structured and multifaceted knowledge within their academic field. This included a broad theoretical foundation in their discipline as well as deep, specialised expertise related to their specific research topic. Their

expertise was primarily rooted in their dissertation research and had evolved over an extended period of time.

> *"My expertise is based on the fact that I've worked and written a dissertation on a specific topic. I continue to research within the same area, so it is, of course, essential."*

The doctoral graduates emphasised that they were experts in their specific research field, but this did not exclude their ability to manage and contribute to broader, interdisciplinary contexts. At times, they expressed frustration with misconceptions that portray PhDs as narrowly specialised theorists disconnected from practice.

> *"I see that, as an expert, I possess skills that would be valuable to many other organisations beyond universities. I wish there were more of a shift in attitude—so that more organisations besides universities would more readily consider hiring doctoral graduates."*

The process of developing theoretical expertise was described as at times challenging, yet highly motivating. When research did not progress, it led to frustration and self-doubt regarding one's level of expertise. In difficult situations, the doctoral researchers coped by refocusing on the broader picture of their research and breaking it down into smaller, manageable parts. The doctoral degree itself was not considered a sufficient motivator due to the title alone; rather, they were driven by the pursuit of substantive, content-based expertise. The doctoral graduates viewed their published scientific articles as a key indicator of their theoretical development. Theoretical expertise was regarded as important and became a central, almost self-evident, dimension of the doctoral journey.

> *"I have perhaps developed the most expertise in research and research methodology, including the ability to evaluate the quality of international articles and the data they use. I can critically assess research, and these skills have continuously deepened over time—covering a wide range of knowledge related to conducting research, some of which may even feel self-evident by now."*

Practical Expertise

According to the doctoral graduates, practical expertise was closely intertwined with theoretical knowledge in their discipline and could not be separated from it. Practical expertise was framed as general academic skills and competencies. It developed through the practical phases of the dissertation process and across different contexts. Taking part in the practical aspects of research made the multifaceted nature of scholarly work more tangible.

> *"There was so much else to do—you couldn't just write the dissertation. You had to publish other papers and get involved in many other activities too."*

Research was described as a multi-phase process, the progress of which could not be reliably predicted in advance. Doctoral studies had helped them develop a better understanding of research processes and a readiness to analyse critically—also across disciplinary boundaries. They had also learned to take criticism as a tool for improving the quality of their work. In addition to their critical stance, they described having grown into a culture of critical thinking.

> *"Feedback on my research is helpful—it gives me more and more confidence in critical thinking."*

One of the key practical skills was writing project funding applications, both independently and as part of a team. Many said they had learned from failed applications and gained perseverance needed for the process. The importance of applying for funding was emphasised, as both research activity and employment prospects required proactivity and an entrepreneurial mindset. Some participants had strong capabilities and success in securing funding and were skilled in presenting their research in an engaging and understandable way to non-expert audiences. Others acknowledged that this was an area they needed to improve.

> *"I would say that within the study framework, my project application skills remained poor—they could have improved much more."*
> *"From the very start, I was part of a research group, and we were constantly applying for funding. I've been in a very good training environment from the beginning. Of course, it took time, but this is the kind of skill and knowledge you need when building your research profile."*

The significance of practical project expertise varied. For some, it was one of the most essential skills; others found it frustrating and bureaucratic and did not want it to be part of their future job role. Most participants saw a meaningful and organic connection between the content of their expertise and project work. Working on projects also helped them envision their expertise in more practical professional contexts and contributed to understanding potential career pathways beyond academic research.

Language proficiency was mentioned as a practical skill, enabling international networking, in-depth research collaboration, and publication in international journals. Doctoral education also strengthened the ability to transfer their skills across contexts, learn new things, and grasp complex systems. The nature of academic work was characterised as a continual process of learning new research practices and finding new applications. These abilities were seen as helpful for expanding one's competencies and navigating future work in different contexts.

> *"Working in an international community, I have conducted all tasks and written communication in English, which has strengthened my overall communication skills. My language proficiency has supported successful mobility funding applications, and the resulting research collaborations remain ongoing."*

Practical expertise was also associated with the processes of scientific writing. The ability to write and review academic articles was considered central. Academic productivity and publishing in prestigious journals were seen as indicators of both theoretical and practical expertise. Doctoral candidates were eager to publish actively to distinguish themselves from their peers. Understanding the logic of publishing and learning from it continuously was viewed as a critical academic skill. The publication process was described as lengthy, demanding, and exhausting, yet instructive and ultimately rewarding.

> *"I read research with interest and can assess reliability, sample size, and those basic elements. In many ways, that foundation has helped me."*

Some doctoral graduates had extended their practical expertise through pedagogical studies, seeing teaching as a possible though not primary career pathway. Doctoral studies had also enhanced their skills for more hands-on work. Those who transitioned from academic degrees into non-academic fields expressed a particular interest in combining research and practical application in their work.

> *"I'd like to combine working life with research. Researchers are often blamed for handing down advice from their ivory towers. Nowadays, research is much more of an everyday tool—and that's what I'd like to promote."*

Self-Regulatory Expertise

According to the doctoral graduates, the process of completing a PhD was highly self-directed and fostered the development of self-regulatory skills. Writing a dissertation required not only intrinsic motivation and curiosity for the subject but also goal orientation and self-discipline. At times, the research progressed smoothly, while at other times, the frameworks collapsed and had to be reconstructed. A key element of self-regulatory expertise was the constant critical self-evaluation in relation to the demands of scientific work, the perceived meaningfulness of the work, personal endurance, and time management pressures. The doctoral research process highlighted the typical expert-like traits of ownership and developing a personal working style.

> *"When there's a lot of information, you quickly learn to find the essentials. These days, it's impossible to read everything—it's unfortunate. Sometimes you just skim articles and extract what you need to keep things moving. You can't go too deep into all the available information."*

The competitive nature of academia and the doctoral graduates' individual responses to it required strong self-regulatory abilities. For example, externally imposed dissertation deadlines were seen both as motivational and as sources of pressure. Many emphasised the importance of avoiding constant stress and maintaining mental balance. Self-regulatory expertise also included valuing rest and recovery through hobbies and free time.

> *"Sometimes I wonder how I'll manage the next 20 years—maybe I work too conscientiously. I should reflect on what value this research has: a) for me, and b) for anyone else."*

Gaining employment within academia and advancing to positions of greater responsibility required doctoral graduates to understand the logic of academic systems, and to plan and anticipate their own activities—in other words, to demonstrate self-regulatory expertise. They also had to accept the possibility of failure in a competitive environment. The ability to plan and forecast their career trajectories varied among participants. Self-regulatory expertise also entailed recognising one's own weaknesses in relation to the nature of expert work. The doctoral graduates described the importance of continuous conscious self-assessment.

> *"My project management skills are still developing. I've grown as a writer and improved my international skills—I can use networks and function as an expert. My administrative competence has also grown as I've taken on more responsibility. Now I'm supervising doctoral students and involved in completely new things."*
> *"My strategy to survive it all is to prioritise. You have to be satisfied with your own decisions—you can't constantly be longing for something else or wondering what you* should *be doing—that's where stress comes from. Of course, I feel I should become more international, but at the same time, I'm happy where I am now."*

A defining feature of their self-regulatory attitude was the understanding that expertise is never complete. They were characterised by inner curiosity, a desire to learn, and a readiness to challenge their own thinking—especially within their area of expertise. Satisfaction and a realistic outlook also reflected their growth process as experts. Their passion for a research-based way of working and a desire to know and understand gave depth to the self-regulatory experience of their doctoral studies. Their sense of growing expertise was strong, and they identified multiple contexts for its development and application. Long-term academic training, practical experience, self-monitoring, critical assessment, and social interaction were all key components of their evolving expertise.

> *"All the things I've been able to do and learn have given me knowledge, skills, competence, and the confidence to know that I can handle this work. And I also know where to go for advice if I don't know something. That gives me a real sense of assurance."*

Sociocultural Expertise

Doctoral graduates became integrated into the working culture of their discipline by actively participating in it. They considered their involvement in different communities to be meaningful primarily within the academic sphere, but also in non-academic work environments. Through their dissertation work, they also connected with disciplinary networks. For some, this meant being part of a prestigious and successful international research team; for others, it involved participation in a regularly meeting local doctoral study group. These groups brought peers together through shared experiences of various phases of the dissertation process. Practical

tips, updates on others' research, and the sense of belonging created a sociocultural community. Informal peer support was considered particularly valuable.

> *"It feels really important and is a central space to check in on how things are going. Everyone had very different types of projects, but there were also overlaps, and that was genuinely helpful. We had common ground in terms of methods, findings, and theoretical background—not to mention opportunities to share experiences of the process itself."*
> *"I've done several short research visits abroad in different labs. That's how I've built new networks and gained new expertise."*

The research group was described as the core of research work. Collaborating with others led to continual learning and the development of new research perspectives and topics. Working together, sharing, and being an active member of a community expanded the doctoral graduates' practical and social expertise. It provided opportunities to explore the latest research in their field and to develop sociocultural knowledge. The different dimensions of expertise were deeply interwoven and strongly shaped through social relationships.

> *"I've been in the right place at the right time. There are people who look out for me—people who are aware of my employment situation and advocate for me. The support around me has been strong, the work varied, and I've had many chances to develop myself in different areas. That builds confidence—I know I've given the impression in these networks that I'm a good employee, someone worth hiring."*
> *"I've joined networks through conferences and try to stay in touch with certain people. Now I pitch them ideas and article topics so we can write together."*

Doctoral graduates valued collaboration with colleagues. Engaging in hands-on work, articulating scientific ideas, and collaboratively developing research was highly rewarding. Participation in international research groups also brought insight into theoretical and methodological issues, as well as the collective achievements possible within the scientific community. Some had expanded their collaboration networks and sociocultural expertise beyond academia by working outside the academic community. However, integration into academic communities was sometimes hindered by competitiveness and the uncertainty of employment. Working in academia was not solely a matter of personal ambition or expertise—external factors such as the competitive funding environment set constraints. Opportunities outside academia were appealing, offering more stable and practical job roles. Even short-term positions in non-academic contexts provided chances to network and demonstrate competence.

Engagement in academic communities deepened doctoral graduates' understanding of how academia operates and helped them develop a wide range of skills such as collaboration and tacit knowledge. The career pathways of other experts were seen as examples of different opportunities.

> *"The whole doctoral process is an important journey of growth and development. You learn and grow into expertise during that time. I'd recommend it to anyone who wants to engage in research—even if they don't plan to stay in academia afterward,*

doctoral studies offer a lot. Some might think it's a narrow specialisation, and yes, you do go deep into one topic. But that doesn't mean your expertise is narrow. You learn to search for information, to filter it quickly, to grasp the big picture—these are skills that are undoubtedly useful in all kinds of jobs."

Discussion

This study explored the types of expertise developed during doctoral education, as experienced by doctoral graduates. The research identified that doctoral expertise aligns with the four dimensions outlined by Ericsson et al. (2006): theoretical, practical, self-regulatory, and sociocultural. In addition, doctoral expertise also emerged as integrative and networked (see also Hakkarainen et al., 2002).

According to the participants, theoretical expertise forms the self-evident core of doctoral-level expertise. It is rooted in the content of the dissertation but also extends into broader interdisciplinary themes. Its development is a long, rewarding, and at times challenging process. Practical expertise is tightly connected to theoretical knowledge and is reflected in general academic competencies. It is particularly developed through involvement in the various phases of the dissertation process, such as information processing and publishing activities. Practical skills also include the ability to apply for project funding, which connects doctoral graduates to opportunities beyond the university. Additionally, readiness for continuous learning and language proficiency enables international engagement and adaptation to new contexts.

Self-regulatory expertise develops through the self-directed nature of the doctoral journey, including goal-setting, time management, and efficiency. Understanding research logics and academic competition further strengthens self-regulation. The doctoral process is continuous, and promoting well-being and the ability to detach from research supports sustainability within doctoral education. Sociocultural expertise, on the other hand, grows through participation in disciplinary cultures, networks, and academic and non-academic communities. Research groups and close colleagues form the sociocultural community for the doctoral expert. Social relationships within research contexts facilitate the development of all dimensions of expertise.

Examining doctoral expertise through these dimensions highlights its breadth and, when mirrored against existing research, demonstrates that doctoral graduates possess widely discussed transferrable skills (see Hasgall & Paneoasu, 2022; Hasgall et al., 2019). Expertise evolves into differentiated forms through the process (Sarrico, 2022). Career trajectories vary across disciplines (see also Piironen et al., 2025; Gardner & Doore, 2020; Jaksztat & Gross, 2024; Skakni et al., 2021), and this variation should be acknowledged from the outset of doctoral training. Expertise continues to grow after the doctorate (Cappelli, 2015), which is intrinsic to the nature of expertise (e.g. Ericsson et al., 2006). As doctoral careers progress and contexts change, expertise continuously takes on new dimensions (Waaijer et al., 2017). Mentoring also supports doctoral graduates in terms of career sustainability and lifelong learning (Maunula et al., 2024).

The participants in this study represented a range of disciplines, which reflects the diverse contexts of doctoral education. This diversity in background has also

been recognised in previous research, and individual differences cannot be standardised. Doctoral education should embrace and accommodate individual variation as part of career development. While research has identified key influences on career pathways, these influences are not always sufficiently integrated into doctoral education practices (e.g. Piironen et al., 2025). Although evidence-informed development and leadership should be standard in academia, in practice it often challenges already time-pressed academic staff.

Expanding doctoral training to include information on the development of expertise, disciplinary career pathways, and employment opportunities would strengthen doctoral candidates' self-regulation, agency, and awareness of potential career pathways. Rethinking and clarifying supervisors' roles and profiles—possibly extending beyond academic subject expertise—would also support development. A single professor cannot be expected to master every aspect of the doctoral training process alone.

Wider employment of doctoral graduates across sectors requires both academia and external stakeholders to recognise the breadth of doctoral expertise. As highlighted by the doctoral graduates in this study, they are frustrated by misperceptions of PhDs as overly theoretical and disconnected from practice. Doctoral expertise takes different forms in different contexts. The increasing number of doctoral graduates and their employment outside universities presents a significant challenge to the content and practices of doctoral education (reference missing). While doctoral education cannot be expected to fully equip graduates with all transferrable skills, career guidance should help identify broader career pathways. The responsibility for defining expertise and finding career options should not fall solely on the doctoral researcher. An effective doctoral education system supports graduates in finding roles that benefit society. At the same time, employers must also commit to ongoing learning, offering professional development in collaboration with universities.

This study shows that doctoral education cultivates differentiated forms of expertise that are not yet fully recognised, but which could be valuable across sectors if their development were more consciously guided. Doctoral expertise is shaped and refined at the intersections of different contexts. Raising meta-awareness of the dimensions and processes of expertise, and engaging in dialogue across fields, supports doctoral graduates in developing and applying their expertise more effectively. Public discussion around the nature of expertise may also help clarify expectations of experts across sectors.

The doctoral process builds a diverse, and in some cases yet unrecognised, body of expertise. The skills learned have many potential applications in scientific, professional and even everyday life. However, the fact that these skills learned and honed during doctoral studies are largely hidden limits their potential for exploitation in different contexts. It is essential that one of the starting points for doctoral training is that the expertise of the doctor is broad and could be used and further refined in new and diverse ways in different contexts. The expertise of doctors is built up on an individual basis, and taking this into account is part of sustainable doctoral training for the future.

The implementation value of this research lies in recognising the importance of doctoral graduates' experiences in shaping the development of doctoral education. The diversification of career pathways can be seen as an opportunity to reform training in response to these realities (Coates et al., 2020). However, we stress the need for multifaceted development: specialised supervision, comprehensive guidance for students, and enhanced agency through increased awareness. As a future research avenue, it would be valuable to gather descriptions of doctoral education contexts and best practices across Europe to further inform development. In addition, more research is needed on specialised supervisory practices and the evolving dimensions of supervisors' expertise.

Conclusion

This study demonstrates that doctoral education cultivates a multifaceted and evolving form of expertise. Doctoral graduates develop theoretical, practical, self-regulatory, and sociocultural competences, which are further shaped through integrative and networked experiences across contexts. These forms of expertise are closely interlinked and contribute to doctoral graduates' capacity to navigate complex academic and professional environments. The findings highlight the importance of recognising individual and disciplinary variation in expertise development. As doctoral graduates increasingly pursue diverse career pathways, there is a growing need to reform doctoral training in ways that foster agency, transferable skills, and awareness of employment opportunities. More intentional support through mentoring, supervisory development, and career guidance would better equip doctoral researchers to apply their expertise beyond academia. Doctoral expertise continues to evolve throughout the career trajectory, responding to changing contexts and societal needs. Its full value is not yet fully acknowledged across sectors, but with more deliberate structures and cross-sector dialogue, this potential could be more effectively realised. Developing doctoral education based on graduates' experiences can serve as a foundation for rethinking practices, clarifying expectations, and strengthening the societal relevance of doctoral-level expertise.

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Studying Sustainably: An Empirical Study on the Importance of Sustainability when Choosing a University

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The aim of this study is to analyze the importance of sustainability in students' decisions for a course of study and a place of study and thus for a university. Empirical data from students are collected and analyzed. Results show that students have an inconsistent and incomplete under-standing of the concept of sustainability. It is the task of a university to close this gap. Although the idea of environmental protection has little influence on the choice of means of transportation to get to university, almost all respondents rated public transport connections to the university as important when choosing where to study. Furthermore, there is no strong correlation between choosing a sustainability-related degree course and one's own (sustainable) behavior in everyday life. However, students with a sustainability focus in their degree course are more likely than students without a sustainability focus to imagine working in such a professional field in the future. In general, the sustainability orientation of the university does not play a role for prospective students when choosing a course. Only students who are already interested in sustainability pay attention to this criterion when choosing their university. If universities want to attract sustainability-conscious students, they should make sure that they not only focus on sustainability in terms of content, but also provide a sustainable campus.

Keywords: study place selection, study place decision, student mobility, sustainability, university, university policy, career choice

Introduction

The Paris Climate Agreement has brought CO_2 emissions and sustainability to the center of the political debate and the public eye. Countries that ratified this agreement are bound to find ways to install climate mitigation measures as well as sustainable and innovative ways to alter mobility, production, education and other parts of life (European Commission, 2024; Hoffmann & Paulsen, 2020; United Nations, 2015). Besides that, other national and international (political) frameworks have been established to bring forward a sustainable transformation such as e. g. the Green New Deal (European Commission, 2024) or the 2030 Agenda for Sustainable Development (United Nations, 2024a). The latter has 17 goals at its core that should try to create context for action to overcome social and environmental challenges. The UN member states have adopted the SDGs since 2015 (United Nations, 2015).

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SDG 4 particularly focuses on "inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2024b). This includes the creation of learning opportunities at primary, secondary and tertiary educational institutions (Chankseliani and McCowan, 2021). But also the other SDGs might play an important role in educational institutions, as they might impact or become more and more integrated into study and educational programs. Education for sustainable development is viewed a central element to prepare people and support them in gaining knowledge and skills for a transformation towards sustainability (Bauer et al. 2021; Holst, 2023). Given the point of view that sustainable development and the role that educational institutions might play in it is of increasing importance, the objective of this study is to gain an insight into whether students give sustainability the same value regarding their study choices. The study particularly tries to analyze, whether sustainability is of importance for the choice of a study program, a study location and as a result for a university. The results of the study are intended to contribute to a better understanding of the importance of sustainability in the university education sector and to derive, possible university policy recommendations for universities.

Literature Review

Focus and Method of the Literature Review

A systematic literature review is required to analyze the importance of sustainability in students' decisions on a course of study and a place of study and thus on a university. The literature analyzed publications from the last five years (2019-2023) that contain the key words "study place selection", "study place decision" and "sustainability" (Eco, 2015). However, not only the accuracy of fit, but also the quotability of the sources was considered when selecting the literature. Thus, only publications from journals with a double-blind review procedure were considered here. The literature selected and quoted in this study also has its origins from ranked journals that are listed in the VHB-JOURQUAL 3 ranking (https://vhbonline.org/service/vhb-jourqual/vhb-jourqual-3).

In addition to the literature analysis, secondary data analysis is used in this study. It enables the re-evaluation of data to answer new questions based on existing data (Glass, 1976).

Sustainability and Choice of University

Public awareness of environmental protection and, as a result, sustainability continues to grow (Sugiarto et al., 2022). Looking at the development of professions, it becomes clear that there is an increasing number of professions related to sustainability (Carballo-Penela et al., 2020; Karaca-Atik et al., 2023). Sustainability is thus also becoming increasingly important in the development of study programs at universities (Salovaara, 2021; Samuelsson & Lindström, 2022) and the number of sustainability related study programs is therefore increasing (Alexander et al.,

2022). The increase can also be explained by the fact that educational institutions play a central role in creating a sustainable future (Leal Filho, 2011; United Nations, 2024 b). Apart from the SDGs of the United Nations that include the role of education as pathway to sustainability, the United Nations have initiated more programs that concentrate on education in the last years. Thus, a "Decade of Education for Sustainable Development" was declared for the years 2005-2014, the UNESCO Global Action Programm on Education for Sustainable Development was installed (Unesco, 2016) and already in 2007 the Principles for Responsible Management Education (PRME) were started as an UN initiative (PRME Secretariat, 2024a; PRME Secretariat, 2024b; Figueiró et al., 2022). All these initiatives recognize the importance of (higher) education for sustainable development and foster actions to spread knowledge and to acquire necessary skills.

Thereby, university education cannot only encourage future consumers to adopt more environmentally friendly behavior (Begum et al., 2021; Maunula, Maunumäki, & Lähdesmäki, 2024), but it also aspires to provide the next generation of future business practitioners and career starters of all professions with necessary skills for a more sustainable economy and institutions (PRME Secretariat, 2024a; PRME Secretariat, 2024b; Figueiró et al., 2022; Holst, 2023; Karaca-Atik et al., 2023).

Against this background manifold research has emerged around sustainability and (higher) education. While some studies concentrate on different dimensions or barriers of the uptake of holistic approaches that might influence the integration of sustainability content into higher education organizations (e.g., Figueiró et al., 2022; Holst, 2023; Sidiropoulos, 2018), other studies investigate the necessary skills in detail (e.g., Karaca-Atik et al., 2023).

According to Fanea-Ivanovici and Baber (2022), sustainable universities do not only positively influence students' attitudes towards sustainability, but also encourage them to engage in sustainable entrepreneurial activity. This encouragement can have a scaling effect, as graduates have the intention to found sustainable start-ups and thus make sustainability more visible in everyday life. According to Sugiarto et al. (2022), however, it takes more than just a curricular anchoring that addresses and promotes sustainability to create a "sustainable campus". Callewaert et al. (2015) describe a culture of sustainability at universities as one in which university members (students, teachers, staff) are aware of environmental, social, and economic challenges and lead a sustainable lifestyle. However, the concepts of sustainability and sustainable development are defined differently by each individual and might be influenced by gender, age, attitude and further personal or educational aspects (Owens & Legere, 2015; Oberrauch et al., 2023, Sidiropoulos, 2018; Sundermann & Fischer, 2024). The literature review shows that students usually only mention ecological, i.e., environmental, criteria of sustainability and that social or economic criteria are clearly in the background and that less than a quarter of students have a balanced view of sustainability (Alexander et al., 2022). Students studying in sustainability-related study programs are an exception here, as these students have a broader understanding of sustainability (Salovaara et al., 2021).

So far, universities have made little effort to establish a uniform definition of sustainability at their educational institution (Owens & Legere, 2015). It is therefore of great importance that institutions close this definition gap by taking a

clear position and establishing a uniform definition (Alexander et al., 2022). Changing curricula towards more sustainability-related content is one challenge that universities have to face. They also increasingly are challenged to work on implementing sustainability in their governance and operational field (Holst, 2023; Leal Filho et al., 2023). Thus, e.g., paperless administration and resource-efficient buildings, for example, are also seen as fundamental to sustainable universities. In particular, the climate efficiency of buildings is a priority for students when it comes to the "campus culture of sustainability"; recycling and energy-efficient or energy-saving concepts are also important. Social or economic aspects such as participation in committees by underrepresented groups are not present for most students (Alexander et al., 2022). It should also be noted that the proportion of female students at tertiary education institutions is steadily increasing and that women are more aware of their responsibility towards the environment than men (Garcia-Salirrosas, 2023). In terms of sustainability when choosing a mean of transport to get to university, for example, women tend to walk, take public transport or cycle. Men are more likely to choose the car as a mean of transportation (Bagdatli & Ipek, 2022). However, the distance to the university and the socio-economic status of the students are also decisive factors (Urmi, 2022).

In times of demographic change in Europe, universities are competing for students. Due to the sustainability trend, it is in the interest of universities to adapt their study programs accordingly. However, the sustainability of a university itself can also become a competitive advantage for a university; they already advertise with figures on CO_2 emissions, for example. However, it should be noted that so far there are only very limited correlations between the institutional environmental performance and the sustainability initiatives of educational institutions. Accordingly, there are no statistically significant correlations between existing sustainability initiatives and greenhouse gas emissions or energy and water use (Lang, 2015).

The described necessity for sustainability education and assumed benefits for a sustainable transformation as well as the institutional efforts of universities to become more sustainable and to broaden their range of sustainability related study program are only one side of the medal. The other side would be, whether students also request more sustainability related content, if they want to choose a sustainable career, if sustainable education has impacted on their views and what affects their choices (Fleșeriu et al., 2020; Leal Filho et al., 2023; Oberrauch et al., 2021; Sidiropoulos, 2018). Understanding the motives for study choices is an emerging research stream, not only related to sustainability, but also to success in finalizing studies, building certain competencies and employability (Fleșeriu et al., 2020; Oberrauch et al., 2023). For example, Oberrauch et al. (2023) investigated the relevance of intrinsic and extrinsic motives for study choices and levels of engagement on teacher and non-teacher training students and found out that study choices are mostly driven by intrinsic motivations, but gender, age, sustainability concepts and sustainability related self-efficacy might play a role as well.

Research Gap and Research Questions (RQ)

This study likes to contribute to this field of research by conducting a survey at a German university, as it might show which university activities have an effect or how and whether they could be adapted to further support sustainability education or where these activities reach their limits. The literature review integrates the present study into the state of research. It encompasses the indexing and processing of the findings documented in literature (Snyder, 2019).

Based on this, the following six research questions (RQ1, RQ2, RQ3, RQ4, RQ5 and RQ6) were derived to identify the existing research gap:

RQ1: What understanding do students have of the concept of sustainability? RQ2: How important is the mean of transportation to the university when choosing a university?
RQ3: Is there a connection between choosing a sustainability-related course of study and one's own (sustainable) behavior in everyday life?
RQ4: Which students can imagine working in a sustainability-related field in the future?
RQ5: Does the sustainability orientation of a university play a role for prospective students when choosing a course of study?
RQ6: What do universities need to do to recruit sustainability-conscious students?

Methods

The study was conducted at Heilbronn University. A convenience sampling approach was used, as the survey link was distributed via WhatsApp to reach a wide range of students from different study programs. Access to the questionnaire was provided digitally via a link that led to the online survey (Wagner-Schelewski & Hering, 2019). A total of 122 students took part in the online survey from late April to early May 2023. The sample consisted of 57% women, 41% men and a small proportion of diverse participants.

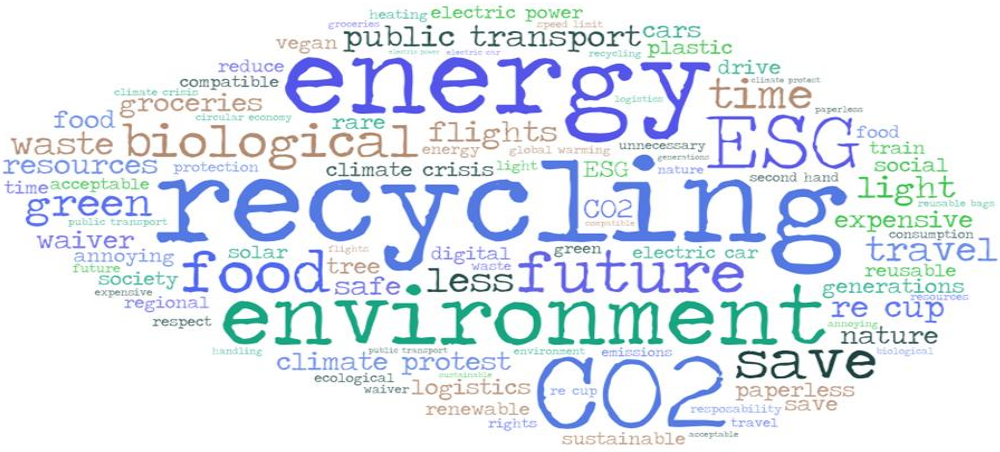
The questionnaire was developed based on insights from the literature review. Therefore, relevant variables and constructs related to sustainability in higher education could be derived, which improved the structure of the research study. The questions were designed to directly correspond to the six research questions (RQ1, RQ2, RQ3, RQ4, RQ5 and RQ6) to ensure that the survey captured the key aspects of the paper. A quantitative cross-sectional design was chosen to capture students' attitudes and perceptions at a specific point in time and to provide a snapshot of their views on sustainability when choosing their course and place of study.

The questionnaire consisted of ten items, including Likert-scale questions to assess students' attitudes, one open-ended question, and one ranking question. The structure aimed to balance quantitative measurability with opportunities for open feedback. A small pretest with a subset of students was done to ensure clarity and comprehensibility of the questions before launching the full survey. Descriptive statistical procedures are used for data analysis and interpretation.

Results

The survey results show that despite the increasing importance of sustainability, students do not have a complete overview of this topic and therefore do not provide a uniform definition, which is in line with findings of other studies that constitute that the concept(s) of sustainability among students is diverse and influenced by factors such as age, cultural or educational background respectively their study field (Oberrauch et al., 2023; Sidiropoulos, 2018; Sundermann & Fischer, 2024). Figure 1 shows the most frequently mentioned terms relating to sustainability in a word cloud.

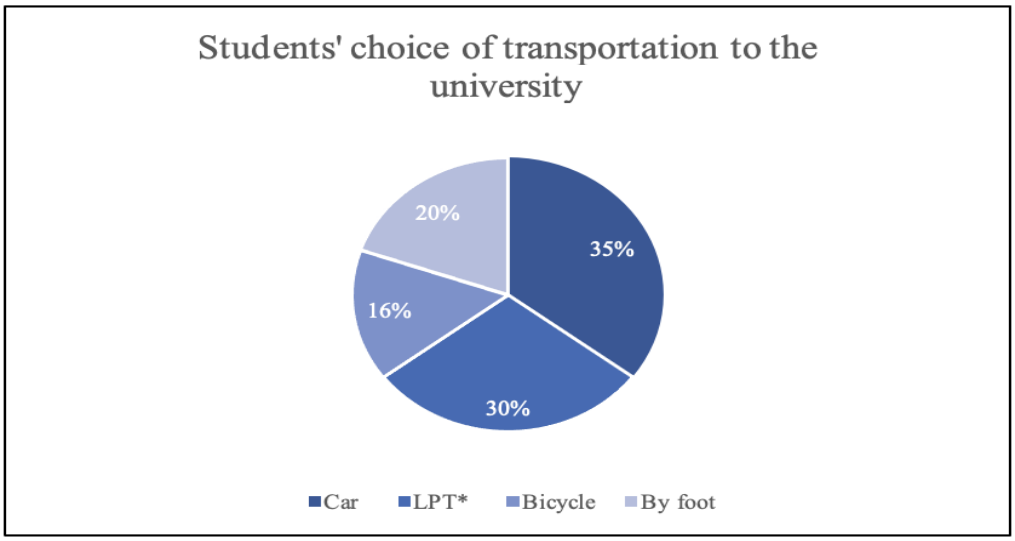
Figure 1. Word Cloud of the Sustainability Criteria



Students see the ecological aspects of the three areas of sustainability almost exclusively; social and economic aspects take a back seat. This result corresponds to the findings of the study by Alexander et al. (2022). It cannot be confirmed here that students from study programs with a sustainability focus have a more balanced overview, as shown by Salovaara et al. (2021). Terms such as “renewable energies”, “environmental protection” and “CO_2 emissions" are also mentioned most frequently among these respondents. The word cloud of sustainability shows a need for action at universities to ensure a uniform understanding of sustainability among their students.

Figure 2 shows the respondents' answers to question 3 “Which means of transport do you mainly use to get to university?”.

Figure 2. Students' Choice of Transportation to the University



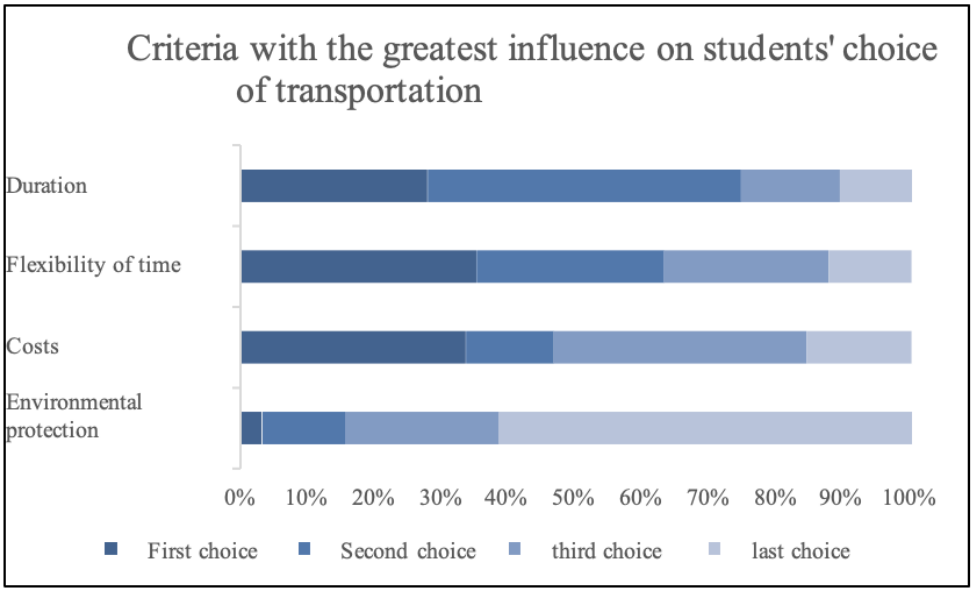
*LPT = Local public transport

The relative majority of students come to university by car. The remaining 65 percent choose a more climate-friendly alternative. However, 36 percent of respondents come by bike (16 percent) or on foot (20 percent). It can therefore at least be inferred that around a third of students live within walking or cycling distance of the campus.

The absence of significant gender differences is particularly interesting when collecting data. The trend observed by Bagdatli and Ipek (2022, p. 25) that men are comparatively more likely to use a car cannot be confirmed. The result of this study is that 36% of men and 34% of women use the car. Although the proportion of men is higher, it is not significant enough to make a generalized statement. The breakdown of the remaining means of transportation also paints an identical picture. None of the means of transportation is clearly preferred by one gender. Only a slight tendency can be seen in the use of bicycles and public transport. While 14% of men use the bicycle, 17% of women choose the bicycle as their means of transportation. Public transport, on the other hand, is slightly preferred by men. 32 percent of the male students surveyed and only 29 percent of the female students surveyed use public transportation. However, this small difference in preferences also contradicts Bagdatli and Ipek (2022).

As already mentioned, it is not possible to break down the choice of means of transportation solely into attitudes towards sustainability and environmental protection. For this reason, the students in this study were asked about the main factors influencing their choice.

Figure 3. Criteria with the Greatest Influence on Students' Choice of Transportation



The duration of the daily commute has the greatest influence, closely followed by time flexibility. The cost of their choice of transportation was usually ranked third by the students and environmental protection was by far the least frequently chosen (Figure 3). This shows that the factors of duration, time flexibility and cost are significantly more relevant than environmental protection when choosing a means of transportation. Thus, the factors identified in the literature review, such as socioeconomic status and distance to the educational institution, are also reflected in the results of the present study.

The relevance of public transport connections for students is also interesting. The average rating of respondents was 4.28 out of a possible 5 points. Public transport users rated the importance of this higher at 4.8. Of course, it is relevant for students who take the bus or train to the university how well the university is connected to public transport. However, students who do not have to rely on these means of transportation also rate the relevance as above average at 4.1. It is therefore important to students that even if they themselves do not use public transport to get to university, other students have the option of a good connection.

Another result of this survey shows that just under ten percent of the students surveyed are enrolled on a sustainability-related course at Heilbronn University. There were no clear differences in terms of the gender of the respondents. It could be assumed that the sustainability of the university is more important to students on sustainability-related courses than students on courses without sustainability content.

Furthermore, 70 percent of students on sustainability-related courses can imagine working in a sustainability-related profession. 10 percent do not yet know whether they want to work in a sustainability-related profession and 20 percent cannot imagine doing so. If only students on degree courses with no connection to sustainability are considered, the proportion of those interested in a profession with a connection to sustainability is significantly lower at around 40%. Female students are slightly abler to imagine working in a sustainable profession after

graduation. Only 47 percent of male students answered yes to this question, while 52 percent of female students answered yes. Another result of the survey is that all students who place a lot or very much value on sustainability in their everyday lives can also imagine working in a sustainability-related career.

A comparison of the average values for the question "How important is sustainability to you in your degree program?" and the question "How much value do you place on sustainability in your everyday life?" reveals the following: More students attach importance to sustainability in their private lives, with an average of 3.3 out of 5 points, than rate sustainability in their degree program as important. The average for the latter is 2.6 out of 5 points.

As outlined in the study by Sugiarto et al. (2022), universities can have a major influence on students' attitudes towards sustainability. For example, through curricula that focus on sustainable content. The importance of such a curriculum was rated as not very high by the respondents with an average of 2.68 out of 5 points. The average answer of 3.9 for students attending a sustainability-related degree course is significantly higher than that of students on other degree courses at 2.6. And when it comes to assessing the importance of the university's climate footprint, students on sustainability-related degree courses also rated the relevance higher at 3.4 than their fellow students with an average answer of 2.8. This trend is not surprising and shows that both groups have chosen suitable degree courses in line with their preferences.

Accordingly, this data can also be used to answer the question of whether universities should actively advertise sustainable course content and a sustainable campus. For the students surveyed, the sustainability of the university is of secondary importance and therefore does not constitute a competitive advantage over other universities. However, students who are already interested in studying sustainability-related courses will evaluate and select their future university in terms of sustainability. As mentioned above, the main focus is on the university's environmental protection and climate compatibility and not on social or ecological aspects. Accordingly, advertising with climate-friendly and sustainable factors only makes sense for a university and sets it apart from other universities if the course content is also geared towards sustainability.

Discussion

There is no strong correlation between choosing a sustainability-related degree course and one's own (sustainable) behavior in everyday life (RQ3). The reasons for this may be manifold as research on motives for study choice are diverse, complex and individual. What needs to be considered as well is that besides the big role that especially intrinsic motives play, can maybe explained with the so-called attitude-behavior gap (Oberrauch et al., 2023). However, students with a sustainability focus in their degree program are more likely than students without a sustainability focus to imagine working in such a professional field in the future (RQ4). In general, the sustainability orientation of the university does not play a role for prospective students when choosing a course. Only students who already

show an interest in sustainability pay attention to this criterion when choosing their university (RQ5). Nevertheless, other factors come into play for study choices that are of importance for the individual and cannot be overlooked or even changed. For example, success in finalizing studies, building certain competencies, social status that can be gained, gender, social and cultural background as well as employability and personal skills and interests are to mention here (Sundermann & Fischer, 2024; Fleșeriu et al., 2020; Oberrauch et al., 2023). Oberrauch et al. (2023) also remark that the possibility to experience self-efficacy might have an effect as well. This shows limits and challenges to universities and their sustainability activities. Although the idea of environmental protection has little influence on the choice of means of transportation to get to university, 65 percent of respondents still use a climate-neutral or at least environmentally friendly means of transportation. However, public transport is only used by around a third of respondents. Nevertheless, almost all respondents rate the importance of local public transport connections as very significant. Accordingly, public transport connections to the university play a major role in the choice of study location (RQ2), which is a valid reason. Offering maybe more online course formats or self-learning courses might be an idea that universities have to investigate for themselves, if they want to attract students from different locations.

Conclusion

Limitations and Future Research

The sample size of this study is quite small, as only students from Heilbronn University have been integrated. That means that also the variety of fields of study is limited as well. And like any study based on convenience sampling, this research is subject to sampling error because participants were not randomly selected but recruited via WhatsApp. In addition, the online survey format may have influenced response behavior due to self-selection bias. It is therefore questionable to what extent the available results can be transferred to a broader student population. Furthermore, the choice of a written online survey and thus quantitative data collection means that the response options are standardized and thus the variety of feedback is limited. The choice and depth of questions also affected the informative and interpretative value of the answers received. Conducting qualitative data collection in the form of interviews, for example, might have left more scope for detailed answers. In addition, distortions of the study results cannot be ruled out, as the proportion of women surveyed is significantly higher than the proportion of men surveyed. Average values in which no attention was paid to gender-specific differences are therefore more influenced by female students in percentage terms. As found in other studies gender might have an effect on motives for study choices, but also on the understanding of the sustainability concept (Oberrauch et al., 2023; Sundermann &d Fischer, 2024).

Nevertheless, the study provides important insights into students' attitudes towards sustainability and serves as a basis for further, more representative research.

Awareness of sustainable action is increasing in society and that this is also having an impact on various professional fields and courses of study. Future studies could, for example, analyze the effectiveness of university sustainability strategies on students. Or how the interest of students in sustainability-related courses can be increased. Also, understanding motives for study choices in more detailed way might be helpful for universities, but also possible employers.

Practical Implications

The students demonstrate an inconsistent and incomplete understanding of the concept of sustainability. It is the task of a university to close this gap. It is recommended that the university establish a definition of sustainability and incorporate it into the university's program development and communication (Alexander et al., 2022). This can be done through initiatives with specific branding, promoting interdisciplinary collaboration and supporting learning inside and outside the classroom (Perrault & Clark, 2017) (RQ1). Furthermore, if universities want to recruit sustainability-conscious students, they should ensure that they not only focus on sustainability in terms of content, but also provide a sustainable campus (RQ6). As other research suggests, it would also be important to not only add sustainability into a few courses, but to understand sustainability as a whole institution effort. Also, revisiting curricula as well as learning formats is found to be crucial to increase the understanding of the concept of sustainability and to increase engagement and feelings of self-efficacy among students (Holst, 2023; Sidiropoulos, 2018; Leal Filho et al., 2023; Oberrauch et al., 2023; Sundermann & Fischer, 2024). Universities might start with conducting their own survey to find out about the situation at their institution and to adapt future measures accordingly.

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Enhancing Sustainability Competence: A Case Study of Physics and Mathematics Curricula at the University of Maribor

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Sustainability competence is increasingly recognized as a vital skill for addressing global environmental challenges. As societies transition to sustainable energy solutions, individuals must acquire the knowledge and skills to make informed decisions. According to the European sustainability framework GreenComp, competences supporting green transition are categorized into embodying sustainability values, embracing complexity, envisioning sustainable futures and acting for sustainability. This study examines the development of sustainability competence within the Physics and Mathematics programs at the Faculty of Natural Sciences and Mathematics University of Maribor. The analysis focuses on compulsory and elective courses to evaluate how curricula have adapted to challenges and market needs. Additionally, the evolution of teaching methodologies and their impact on students' understanding of sustainability is assessed. Closed-ended questionnaires were distributed to measure graduates' perceived sustainability competence. The findings indicate graduates are confident in critical thinking and problem-solving. However, fewer than a third felt adequately informed about energy policies and the circular economy. Furthermore, only half reported sufficient knowledge of energy-saving practices, energy sources, sustainability concepts, and energy efficiency. The results highlight that while the curricula successfully foster general skills in critical and exploratory thinking, greater emphasis is needed on specific topics, particularly energy policies and sustainability practices.

Keywords: sustainability, higher education, curriculum analysis, graduate competences, questionnaire

Introduction

The green transition and digital transformation represent two of the most pressing and interconnected global challenges of the 21st century. Their growing influence is reflected in the increased expectations placed on educational systems worldwide, particularly on higher education institutions, which are expected to not only transmit disciplinary knowledge but also foster the critical competences needed to navigate and shape sustainable futures.

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In response to accelerating environmental degradation, energy crises, and social inequalities, the European Union has launched several strategic frameworks, most notably the European Green Deal and the Digital Agenda for Europe. These initiatives aim to promote a just and inclusive transition toward a climate-neutral, resource-efficient, and digitally empowered society (European Commission, 2019; 2020). Within this vision, education, especially higher education, plays a crucial enabling role by equipping current and future professionals, educators, and decision-makers with the competences necessary for system-wide transformation.

Traditional curricula in science and mathematics, while foundational, often remain content-heavy and decontextualized, focusing predominantly on theoretical knowledge and procedural skills. However, in the face of complex global crises such as climate change, biodiversity loss, and the energy transition, this approach is no longer sufficient. Instead, there is a growing need to shift toward competence-based education, where students not only acquire knowledge but also develop values, dispositions, and action-oriented skills necessary for sustainability and resilience (UNESCO, 2020).

One of the most comprehensive conceptual tools to support this educational transformation is GreenComp – The European Sustainability Competence Framework (European Commission, Joint Research Centre, 2022). Developed by the European Commission's Joint Research Centre, GreenComp defines 12 interrelated sustainability competences, structured into four interconnected clusters:

1. Embodying sustainability values, which involves cultivating a sense of justice, equity, responsibility, and respect for all forms of life.
2. Embracing complexity, which refers to systems thinking, critical reflection, and the ability to deal with uncertainty and interdependence.
3. Envisioning sustainable futures, which include creative imagination, foresight, and the ability to generate transformative alternatives.
4. Acting for sustainability, which emphasizes individual and collective agency, political literacy, and the capacity to initiate and sustain change.

GreenComp is intentionally designed as a conceptual and non-prescriptive framework, making it adaptable across diverse educational levels, national contexts, and disciplinary domains. However, for its effective implementation, it requires systemic changes in curriculum design, pedagogical practice, and assessment culture—especially in traditionally discipline-centered fields such as physics and mathematics, where sustainability themes have often been underrepresented.

Within this context, the Faculty of Natural Sciences and Mathematics at the University of Maribor (FNM UM) initiated a pilot research project to critically evaluate the current integration of sustainability and digital competences into its Physics and Mathematics study programs. In addition to these academic tracks, the project also examined the Subject Teacher study programs (Educational Physics and Educational Mathematics), recognizing the crucial role they play in preparing future physics and mathematics teachers to address sustainability challenges and digital transformation in education. The project responds to the urgent need to understand

how natural science and STEM education can be better aligned with the goals of sustainability and digital transformation.

The core research question guiding this study is: *To what extent do the current curricula foster competences that are consistent with the GreenComp framework and meet the evolving expectations of the 21st-century labor market?*

To address this question, the research team conducted a comprehensive curriculum mapping and quantitative competence assessment using validated instruments aligned with GreenComp and DigComp 2.2 frameworks. The resulting analysis provides empirical evidence of both strengths and gaps in the current educational approach and offers practical recommendations for future curricular reforms.

Ultimately, this study contributes to the emerging body of knowledge on how physics and mathematics education can play a transformative role in achieving sustainability goals, not only through disciplinary excellence but also through transdisciplinary, ethically grounded, and action-oriented learning.

Literature Review

The challenges identified in the curricula of Physics and Mathematics programs at FNM UM, particularly the underrepresentation of socio-political and action-oriented sustainability competences, are not unique to Slovenia. Similar findings have been reported across several EU member states, indicating a broader systemic issue in the integration of sustainability in higher education, especially within STEM disciplines.

For example, Leal Filho, Shiel, & do Paço, (2016) conducted a multi-country study analyzing sustainability integration in European universities and found that while environmental awareness among STEM students was generally high, competences related to civic engagement, policy literacy, and interdisciplinary collaboration were significantly weaker. This reflects a persistent imbalance between cognitive and affective-behavioral dimensions of sustainability learning.

A detailed examination by Mokski, Leal Filho, Sehnem, & Salgueirinho Osório de Andrade Guerra, (2022) also revealed that engineering and science students often perceived sustainability as a technical challenge, lacking a deeper understanding of its ethical, political, and societal dimensions. Similarly, Rieckmann (2016) emphasized that without pedagogical strategies that actively promote systemic thinking and value-based reflection, students struggle to translate sustainability knowledge into transformative action.

While the cognitive and technical aspects of sustainability are commonly emphasized, there is increasing recognition that digital competence also plays a critical role in shaping students' ability to engage with complex sustainability issues. As Vuorikari, Kluzer & Punie (2022) suggest in the DigComp 2.2 framework, future-oriented education must develop not only digital literacy for information processing but also digital creativity, collaboration, and ethical awareness. However, research (Selwyn, 2021; Sterling, 2019) warns that current digital integration in STEM curricula often remains instrumental, focusing on technical efficiency rather than on fostering reflective and transformative digital agency for sustainability. Furthermore, a study by Dias-Trindade & Moreira (2023) revealed that integrating digital

technologies into formal education relies strongly on funds, opportunities for teacher training, and teachers' perceptions.

In the context of teacher education, the TEESNet project (Ferreira, Evans, Davis & Stevenson, 2019) compared approaches across multiple EU countries and concluded that while frameworks such as GreenComp offer valuable conceptual guidance, their implementation remains superficial unless accompanied by institutional commitment, interdisciplinary teaching teams, and authentic learning environments linked to real-world challenges.

Furthermore, Glover (2023) argued that despite widespread recognition of Education for Sustainable Development (ESD) in policy, its practical realization in higher education curricula tends to be fragmented and discipline bound. This observation aligns with the findings of the present study, where sustainability content is not structurally embedded across core modules but is instead isolated in elective or project-based activities.

These comparisons underscore that the situation at FNM UM is reflective of a pan-European pattern, one in which STEM education is advancing in scientific depth but often lags in transformative capacity. They also point to the urgent need for systemic curriculum redesign that bridges the divide between technical expertise and societal responsibility, particularly in light of global policy agendas such as the European Green Deal and the UN Sustainable Development Goals (SDGs).

These findings resonate with the broader call for transformative education articulated in UNESCO (2020), which urges higher education institutions to move beyond knowledge acquisition and toward fostering sustainability action. Mezirow's (2000) theory of transformative learning further supports this, emphasizing the importance of critical reflection and perspective shifts in enabling students to act as change agents. In this light, STEM faculties must not only adopt frameworks such as GreenComp or DigComp as reference tools but also integrate them into institutional strategy, faculty training, and course-level learning outcomes. Without such alignment, sustainability education risks remaining rhetorical rather than reformative.

A recent study conducted as part of the FORM-STEMA project at the University of Maribor in 2025 supports these broader European trends. The findings reveal that while final-year students demonstrate relatively strong knowledge of basic energy concepts, their understanding of sustainability policies and the ability to make interdisciplinary connections remain underdeveloped. This aligns with earlier research highlighting fragmented curricular approaches and underscores the need for harmonized, cross-sectoral pedagogical strategies that build system-level competences for sustainability.

This aligns with Sterling's (2011) concept of *anticipative education*, which advocates preparing learners not merely for existing roles, but for future complexity and uncertainty. Anticipative education emphasizes foresight, adaptability, and value-driven decision-making, qualities that are increasingly necessary in navigating sustainability challenges in the Anthropocene. Embedding such forward-looking approaches into science education can help bridge the gap between technical expertise and the civic imagination required for transformative action.

Methodology

This study employed a quantitative research approach based on structured survey questionnaires designed to assess self-perceived sustainability and digital competences among students and academic staff (program coordinators). The aim of the research was to determine how effectively the current study programs develop competences as defined in the European reference frameworks GreenComp (European Commission, Joint Research Centre, 2022) and DigComp 2.2 (Vuorikari, Kluzer & Punie, 2022).

Research Instruments

The questionnaires were constructed using indicators derived from the aforementioned frameworks and included Likert-type scales measuring:

- Sustainability competences: knowledge of energy sources, energy efficiency, systems thinking, understanding of policies, and sustainable behavior (based on GreenComp), assessed using a traditionally applied 5-point Likert scale;
- Digital competences: searching, evaluating, and managing information, creating digital content, collaborating via digital tools, and applying ethical and safety standards (based on DigComp 2.2), measured using 8-point Likert scale corresponding to the eight levels of digital skill achievement outlined in DigComp 2.2.

The questionnaire was divided into several thematic sections: (1) general demographic information, (2) self-assessment of competences, (3) perception of the curriculum, and (4) suggestions for improvement. Instrument validation was conducted during the preliminary project phase through expert group consultation and internal pilot testing.

Sample

The sample consisted of final-year students enrolled in the Physics, Mathematics and Subject Teacher Education programmes at the Faculty of Natural Sciences and Mathematics, University of Maribor. A total of 28 students participated in the study. In addition, 4 programme coordinators from both pedagogical and non-pedagogical tracks were included to enable a comparative perspective between students' and coordinators' perceptions of competence development.

The relatively small sample size is explained by the fact that the target population itself is limited, as each study programme has a small cohort of final-year students. Since participation was voluntary and focused exclusively on graduating students at the end of their study cycle, the number of eligible respondents was naturally small but representative of the entire population of the programmes examined.

In order to obtain a broader and more contextually grounded understanding of sustainability competence development in STEM fields, a cross-faculty comparison was included in the research design. The Faculty of Civil Engineering, Transportation Engineering and Architecture (FGPA UM) was selected as a reference group because

it offers STEM-related study programmes with partly overlapping competence goals, yet with a different disciplinary focus. Including this comparison enabled us to examine whether the identified competence patterns at FNM UM were discipline-specific or reflected wider trends across STEM education. Therefore, the comparison with FGPA UM was planned as an integral part of the methodological design, and not only introduced at the stage of analysing the results.

Data Analysis

Data were statistically analyzed using SPSS software (version 27). The following analytical procedures were applied:

- Descriptive statistics: means, standard deviations, and frequency distributions to characterize competence levels across various dimensions;
- Correlation analysis (Pearson's r and Spearman's ρ): to measure the relationship between student and coordinator assessments and to identify agreement in perceived competences;
- Cohen's d: to evaluate effect sizes and the practical significance of observed differences;
- 95% confidence intervals: to assess the reliability of the results;
- Paired t-tests: to determine statistically significant differences in mean ratings between groups (e.g., students vs. coordinators; pedagogical vs. non-pedagogical programs). Although the sample size was relatively small, the use of the t-test was considered appropriate for this analysis. The t-test is robust to violations of normality, particularly when group sizes are small and relatively equal, as was the case in this study. Prior to conducting the t-tests, the assumptions of normality and homogeneity of variances were examined and met. In addition, the t-test was selected due to its suitability for comparing mean values between two groups and its widespread application in educational and social science research. Non-parametric alternatives (e.g., Mann-Whitney U test) were considered; however, these are less powerful when assumptions for parametric testing are satisfied, hence the t-test was deemed the most appropriate method for the research design and data structure.

Statistical significance was evaluated at the $\alpha = 0.05$ level. In cases where significance thresholds were not met, borderline effects were interpreted, and recommendations for further studies with larger samples were provided.

To ensure the credibility and robustness of the findings, several validation procedures were applied. The internal consistency of the survey scales was examined, and descriptive and inferential statistical analyses were used to verify the coherence of response patterns across participant groups. Triangulation was achieved through a combination of methods:

- data triangulation, by comparing responses from students and programme coordinators;
- methodological triangulation, combining quantitative survey results with curriculum analysis; and
- source triangulation, by comparing selected indicators with data from a parallel study conducted at the Faculty of Civil Engineering, Transportation Engineering and Architecture (FGPA UM).

This multi-level triangulation approach strengthened the reliability of the findings and enabled a more comprehensive interpretation of competence development across programmes.

Ethical Considerations

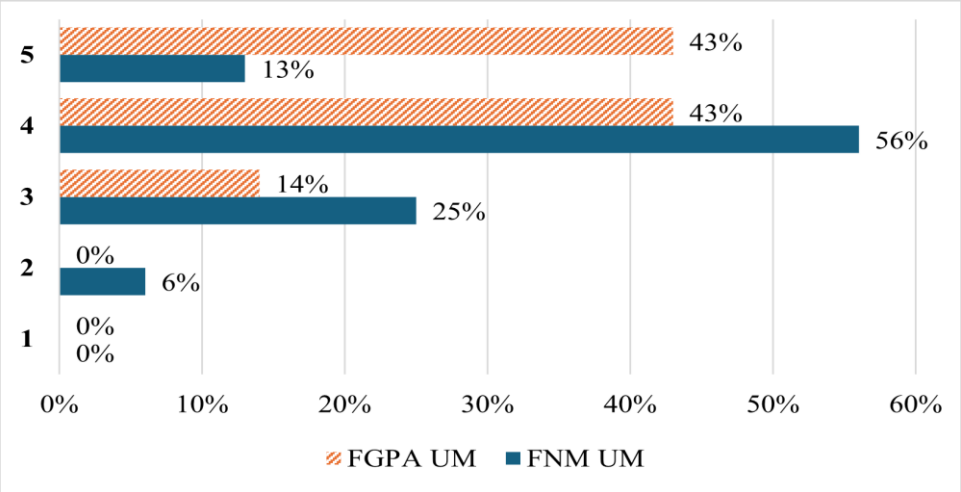
The study was conducted in accordance with the ethical guidelines of the University of Maribor. All participants took part voluntarily and anonymously. The collected data was used exclusively for research purposes.

Results

Energy Literacy and Understanding of Sustainability Concepts

A detailed survey conducted in May–June 2025 among final-year students at FNM UM (N = 28) provided additional insight into specific dimensions of sustainability competence Students evaluated their knowledge and attitudes using a 1–5 Likert scale, where 1 meant "strongly disagree" and 5 "strongly agree". As shown in Figure 1, the highest average score was recorded for understanding energy sources (M = 4.34), followed by efficient energy use (M = 4.30) and sustainable energy production (M = 4.11). These values confirm a strong foundation in core energy-related topics. We compared results with responses of final-year students at FGPA UM.

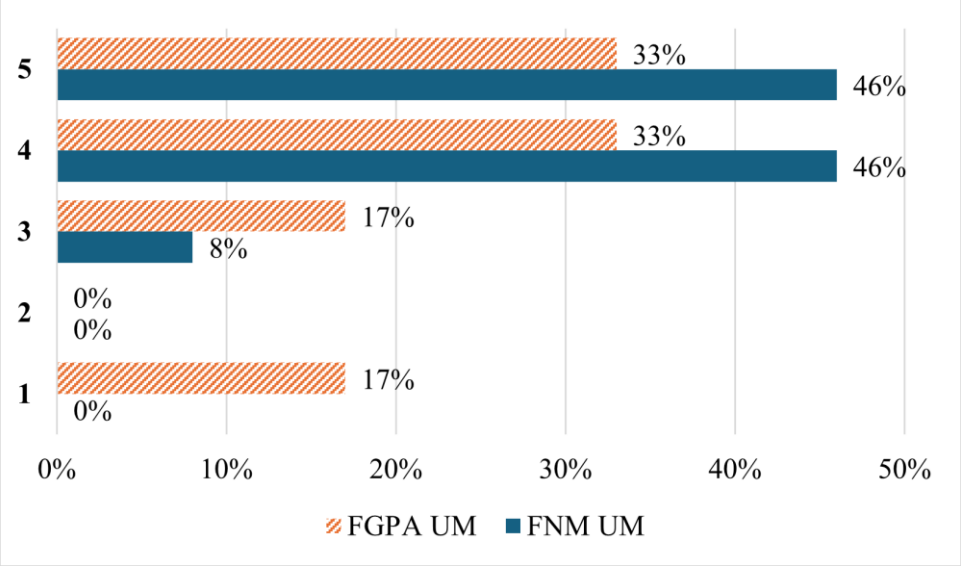
Figure 1. Recognition of Cause-and-Effect Relationships: Results of Student Responses from FGPA UM (orange, dashed) and FNM UM (blue)



Source: own.

In contrast, substantially lower ratings were reported in areas concerning systemic and policy knowledge. Understanding of the circular economy received a mean score of 3.61, while awareness of energy legislation and regulation was rated at only M = 3.32. As presented in Figure 2, students' self-perceived ability to critically evaluate energy policy was also low (M = 3.39), indicating a need for curricular reinforcement in these domains.

Figure 2. Recognition and Application of Measures for Sustainable Resource Management: Results of Student Responses from FGPA UM (orange dashed) and FNM UM (blue)



Source: own.

Survey results from students at the Faculty of Natural Sciences and Mathematics, University of Maribor (FNM UM), indicate a moderate to high level of self-assessed

understanding of basic energy concepts, including energy sources, efficiency, and consumption. Average ratings ranged from 3.7 to 4.1, suggesting that the study programs provide a solid foundational understanding of energy-related science.

However, notable knowledge gaps were identified in more systemic and policy-related topics—such as energy legislation, circular economy, and sustainable development policies. Less than one-third of students rated themselves as adequately informed in these areas. These results point to a limited integration of socio-political and ethical dimensions of sustainability into the curriculum, a trend similarly highlighted in the European GreenComp framework (European Commission, Joint Research Centre, 2022).

A comparative visualization of competence ratings across different sustainability dimensions is presented in Figure 3 (based on student responses), showing both strength in foundational concepts and gaps in applied and policy-relevant domains.

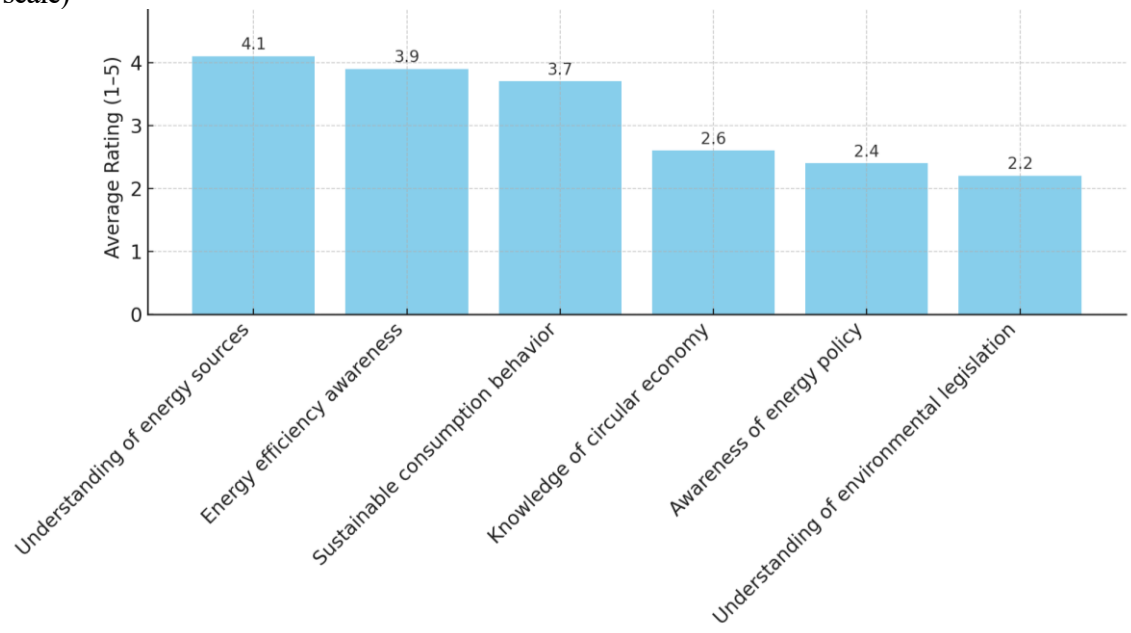
Additional indicators from the survey offer further insight into specific competence areas. For instance, average self-assessment of causal reasoning in energy systems was 3.9/5 among FNM UM students, slightly higher than the 3.4/5 reported by FGPA UM students (Figure 1).

In terms of understanding the circular economy, only 31% of FNM students agreed or strongly agreed with the relevant statement (score of 4 or 5), highlighting a gap in interdisciplinary sustainability knowledge (Figure 2).

Similarly, comprehension of green business principles received the lowest average rating (3.2/5), despite the increasing relevance of these concepts in sustainability education (Figure 3).

These findings point to both strengths and blind spots in current curricular approaches.

Figure 3. Average Self-Assessment Scores of Sustainability Competences (5-point scale)



Source: own.

Statistical Analysis of Program Coordinator Perspectives

A comparative analysis of sustainability competence ratings among various study program coordinators revealed statistically significant differences. Particularly noteworthy is the difference between the coordinator of the pedagogical physics program and the coordinator of the non-pedagogical physics program, where the variation in ratings was statistically significant ($p = 0.028$). This suggests differing perceptions of competence development depending on whether the program is pedagogically or professionally/research oriented. Pedagogical programs may place less emphasis on specific content related to policy, legislation, and practical applications, which could hinder the development of applied competences among students.

Alignment between Students and Program Coordinators

One of the most positive findings is the high level of agreement in competence perceptions between students and the coordinator of the non-pedagogical program ($r = 0.806$; $p < 0.001$). This alignment indicates a shared understanding of competence development within the program. Such consistency is valuable, as it reflects transparent and effective communication between educators and learners. In contrast, correlation with the pedagogical program coordinator was weaker, which may indicate a need for improved reflection on learning outcomes and self-evaluation practices.

Digital Competences (DigComp 2.2)

Students' digital competences were assessed using the DigComp 2.2 framework, where self-assessment used an 8-point Likert scale. Results reveal high levels of digital literacy in basic areas such as:

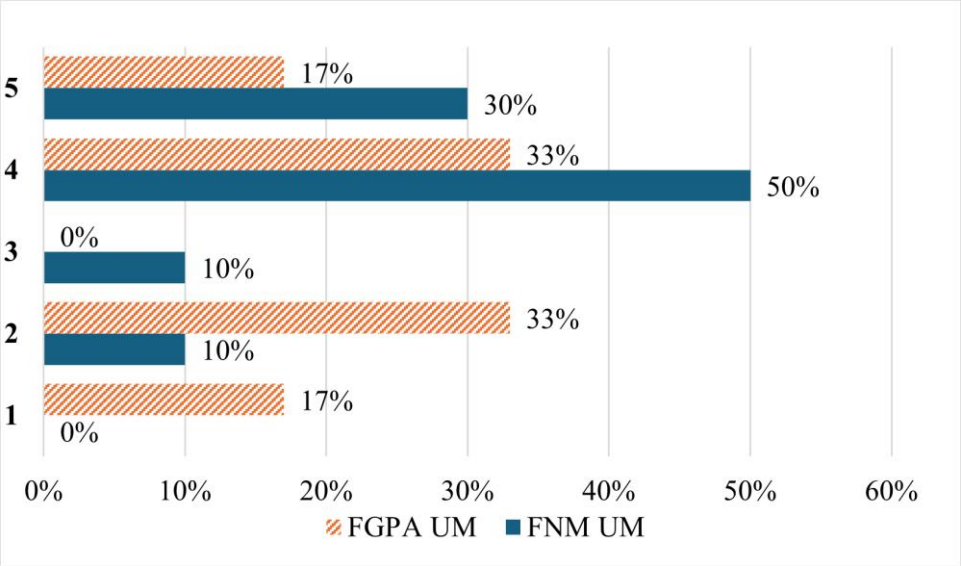
- Information and data literacy (average = 7.1/8)
- Communication and collaboration (average = 6.8/8)

However, notable gaps remain in more creative and productive dimensions. Specifically:

- Creating digital content: average score = 4.0/8
- Programming and innovation using digital tools: average score = 3.7/8

These trends are confirmed by response frequencies: 82% of students felt confident using digital tools for searching and evaluating information, but only 36% in digital content creation and just 18% in applying digital tools across interdisciplinary sustainability contexts (see Figure 4).

Figure 4. Understanding the Basics of Green Business and Sustainable Entrepreneurship: Results of Student Responses from FGPA UM (orange, dashed) and FNM UM (blue)



Source: own.

These results underline a need to shift from passive to active digital engagement, especially in contexts requiring students to create, model, and communicate sustainability-related solutions. This shortfall is increasingly relevant given the growing emphasis on creative digital practices in both education and the labor market (Vuorikari et al., 2022). Similarly, Atanas (2018) found that the use of virtual-physical and physical-virtual manipulatives in physics classes significantly enhances students' active engagement and promotes deeper conceptual understanding.

Final-year students rated their competence highest in technical areas, while lower scores were reported for policy and systems-based sustainability dimensions.

A more granular analysis of the survey data reveals patterns in specific competence areas. Figures 1 through 4 illustrate student self-assessments across various dimensions of sustainability and digital competence. Students generally rated themselves highly in foundational scientific knowledge and digital information processing (Figure 1) but demonstrated lower confidence in applying knowledge to real-world contexts, such as identifying sustainability strategies, understanding green business and entrepreneurship, or engaging in interdisciplinary collaboration. This gap between theoretical understanding and applied sustainability action highlights the need for curricular designs that better integrate civic, economic, and digital dimensions.

Discussion

The results of the analysis indicate that study programs at the FNM UM effectively develop general academic competences, such as critical thinking, analytical problem-solving, and digital literacy, particularly in the context of information

retrieval and processing. These competences form the core of modern university education and align with the 21st-century competence framework (OECD, 2025).

However, the data also reveal significant gaps in content-specific sustainability competences, particularly in dimensions related to the socio-political context, practical knowledge application, and active engagement for sustainability. Students report limited knowledge of energy policy, the circular economy, and systemic aspects of sustainability, which is inconsistent with the goals of the GreenComp framework, especially its pillars *"acting for sustainability"* and *"embracing complexity"* (European Commission, Joint Research Centre, 2022). The inclusion of final-year FNM students in the 2025 survey further strengthens our findings. The comparatively high scores in areas such as systems thinking about energy systems (mean 6.7) and renewable technology analysis (mean 6.9) demonstrate an encouraging alignment with the intended learning outcomes of STEM-integrated sustainability education. These two areas also received the lowest self-assessment ratings, indicating a lack of integrated, applied approaches in the curriculum. These differences are visually illustrated in Figure 3, which shows that competences such as understanding of energy sources are rated significantly higher than those related to policy or systems thinking.

Pedagogical strategies that remain primarily focused on theoretical content delivery are no longer sufficient in light of the rapidly evolving climatic, societal, and technological challenges. Sustainability-oriented education requires a transdisciplinary approach that transcends traditional divisions between the natural and social sciences and enables students to develop competences for real-world problem solving (Sterling, 2001; UNESCO, 2020).

The findings on limited creative use of digital tools (e.g., digital content creation), which students rated significantly lower (4.0/8), further support the need to shift from passive consumption of technology to active, collaborative, and problem-based use. This includes the use of digital tools for data visualization, environmental scenario simulation, and co-creation of knowledge—tools that support GreenComp competences and simultaneously foster student autonomy.

Additionally, the observed statistical difference between pedagogical and non-pedagogical physics programs ($p = 0.028$) suggests structural variation in how sustainability content is embedded depending on the academic orientation. This highlights the importance of ensuring horizontal integration of sustainability competences across study tracks.

The strong correlation between students' self-assessments and the evaluations of the non-pedagogical program coordinator ($r = 0.806$, $p < .001$) reflects well-structured learning outcomes and effective internal communication of competence goals.

From a curriculum development perspective, this calls for a comprehensive reform that would:

- systematically integrate sustainability and digitalization themes into core curricula;
- support the development of competences for civic and political engagement (e.g., agency, collective action);
- implement active pedagogical approaches such as project-based learning, case studies, simulations, and problem-based learning (PBL);

- encourage cooperation with local communities and real-world projects, allowing students to understand sustainability as a practical and participatory process, not merely a theoretical concept.

Finally, it is important to stress that these findings are not unique to FNM UM but reflect broader trends and challenges in higher education across Europe, which is still in the early stages of embedding sustainability competences. Studies such as this one have dual value, as tools for institutional self-evaluation and as scientific contributions to the development of sustainability pedagogy.

While digital literacy is often integrated into STEM education through basic competencies such as information retrieval and data processing, the creative dimension of digital competence remains significantly underdeveloped, as indicated by the lower self-assessment scores in this study. The European Digital Competence Framework (DigComp 2.2) highlights *"creating digital content"* and *"collaborative digital production"* as key areas that support innovation, communication, and critical engagement with digital tools (Vuorikari et al., 2022). However, these aspects are frequently marginalized in STEM curricula that prioritize correctness, technical precision, and individual problem-solving over open-ended exploration.

To enhance digital creativity in physics and mathematics education, a paradigm shift is needed, from instrumental use of digital tools to their transformative and expressive use. This involves embedding tasks that encourage students to:

- Design simulations and models to represent complex systems (e.g., energy flows, planetary boundaries).
- Produce multimedia content, such as educational videos, infographics, or podcasts, that communicate scientific concepts to broader audiences.
- Use collaborative platforms (e.g., GitHub, Miro, Padlet) for co-creating knowledge, designing experiments, or developing open-source tools with societal impact.
- Engage with digital storytelling, linking data analysis with narrative structures that humanize scientific knowledge and give voice to ethical dimensions of sustainability.

Such activities can be embedded into coursework through project-based learning (PBL), interdisciplinary hackathons, or challenge-based modules that address real-world problems through creative digital outputs. Importantly, educators must be supported through professional development to integrate these practices without compromising disciplinary rigor.

As one student noted, "I understand energy efficiency now, but I don't yet feel confident applying it to everyday decisions." Another remarked, "We need more real-world projects, not just formulas and theory. That's when learning becomes real."

By strengthening digital creativity, STEM curricula not only become more engaging and relevant to students' future careers but also contribute to the development of transformative digital agency, the ability to use technology not only to solve problems, but to imagine and shape sustainable futures.

While the findings of this study provide valuable insights into the development of sustainability and digital competences within STEM curricula, several limitations should be acknowledged to contextualize the results and guide future research.

First, the sample size was limited to final-year students and program leaders at a single institution, FNM UM, which may constrain the generalizability of the results. Although the sample was representative of the relevant academic programs within the faculty, broader comparative data from other institutions or faculties (e.g., engineering, social sciences) would enhance the robustness and external validity of the conclusions.

Second, the study relied on self-assessment questionnaires, which are inherently subject to social desirability bias and subjective interpretation. Respondents may over- or underestimate their competences due to a lack of objective benchmarks or varying levels of metacognitive awareness. While validated scales and triangulation with curriculum analysis were used to mitigate these effects, the inclusion of performance-based assessments or external evaluations in future studies would improve data accuracy.

Third, the cross-sectional nature of the survey provides a snapshot of perceived competence at a single point in time. A longitudinal design, capturing students' progression throughout their academic journey, would offer deeper insight into how competences are developed across courses and semesters.

Lastly, although the GreenComp and DigComp frameworks provide comprehensive reference points, their integration into specific disciplinary contexts—such as mathematics and physics—remains methodologically complex. Further refinement of discipline-specific indicators would help bridge the gap between general competence frameworks and concrete curricular outcomes.

By acknowledging these limitations, this study encourages cautious interpretation of the findings and highlights areas for future research and institutional development.

Conclusion

The analysis of the Physics and Mathematics study programs at the Faculty of Natural Sciences and Mathematics, University of Maribor shows that these programs have already successfully fostered some key academic and digital competences. However, in the context of the demands posed by the green transition, there are notable gaps in competences, particularly regarding understanding of energy policies, circular economy principles, and the capacity for sustainability action in broader societal contexts.

To comprehensively strengthen sustainability competences, we propose the following strategic directions, grounded in empirical findings and consistent with European guidelines (European Commission, Joint Research Centre, 2022; Vuorikari et al., 2022; UNESCO, 2020):

1. Structural integration of sustainability-related content—including energy, policy, and legislation—into the core components of curricula. Rather than being optional or peripheral, these topics should be systematically included in disciplinary modules to deepen understanding of the intersection between science and society.
2. Development of interdisciplinary learning modules, connecting natural sciences with social sciences, technology, and the arts. Collaboration with other faculties and programs (e.g., economics, sociology, civil engineering, computer science) can significantly contribute to competences such as systems thinking, multiperspective analysis, and sustainable problem-solving.
3. Active student involvement in sustainability-oriented projects based on real-world needs of local communities. This could include engagement in municipal energy strategies, school campaigns for energy efficiency, or environmental monitoring. These approaches, supported by project-based learning (PBL), enhance students' sense of ownership, civic responsibility, and political agency.
4. Implementation of regular competence assessments using standardized tools such as GreenComp for sustainability, DigComp for digital literacy, and the Energy Literacy Framework for energy-related knowledge. These tools enable comparability, monitoring of progress, and curriculum adaptation in response to labor market and societal changes. These frameworks should not only guide individual course design but be embedded into broader institutional strategies—including curriculum reform, staff training, and quality assurance mechanisms. Future iterations of the program should systematically monitor energy literacy metrics, as recent evidence from the 2025 cohort at FNM UM highlights the critical role of higher education in equipping students with competencies for the green transition.

The successful implementation of these recommendations requires a strategic institutional approach and the support of national policies that recognize sustainability competences as a fundamental component of quality higher education.

Furthermore, aligning study programs with the evolving needs of the labor market and society is essential. As sustainability and digital transformation reshape all sectors—from energy and construction to public administration—graduates must be equipped not only to meet but to lead these transitions. Embedding interdisciplinary and value-driven education enhances both employability and societal resilience.

It is essential that these changes are inclusive, reflective, and geared toward the long-term development of academic communities as key actors in the green and digital transition. In doing so, universities move beyond content transmission and become active laboratories for sustainable futures—training not only professionals, but critical, creative, and courageous citizens of the Anthropocene.

Acknowledgments

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Energy Literacy in STEM: Opportunities for Interdisciplinary Integration in Higher Education

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Energy literacy is increasingly vital for understanding energy flows, managing resources, and addressing global environmental challenges. Initiatives such as the European Green Deal and the United Nations Sustainable Development Goals target climate change, biodiversity loss, and pollution. However, studies indicate that current higher education curricula often fall short in preparing graduates for these challenges. This research conducted a document analysis of the curricula for the Physics, Mathematics, and Civil Engineering study programs at the University of Maribor to identify opportunities for integrating energy literacy. Emphasizing an interdisciplinary approach, we propose an example where students optimize energy efficiency by combining physics, mathematics, and engineering concepts. Students study the energy balance of a building by connecting thermodynamic principles, such as heat transfer, with mathematical techniques, including partial derivatives and differential equations. Measurements using infrared cameras provide hands-on experience in analyzing real-world data. Additionally, students develop models and program simulations to explore energy-efficient design options. Activities also address ecological and economic impacts, encouraging sustainability discussions. The research highlights that significant changes or the introduction of new content in educational curricula are not strictly necessary; rather, the focus should be on innovative teaching methods and the application of established problem-solving approaches.

*Keywords: e*nergy literacy, STEM, sustainable development, interdisciplinarity, higher education

Introduction

Integrating sustainability and digital transformation into STEM education is one of the most important challenges in the 21st century. We are witnessing the effects of climate change, biodiversity loss, and environmental degradation, issues that the United Nations Environment Programme (UNEP, 2021) refers to as the "triple planetary crisis". These urgent problems highlight the need for systemic solutions and a new generation of critically engaged, sustainability-literate graduates. This also implies the importance of knowledge leadership and knowledge sharing as core components of sustainable educational transformation (Rahman et al., 2025).

In this context, energy literacy emerges not only as a foundational skill but also as a concrete and integrative entry point for embedding sustainability into STEM

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education. Unlike broader sustainability frameworks, energy literacy directly links scientific principles, technological applications, and societal impacts. It enables learners to contextualize theoretical knowledge, such as thermodynamics or mathematical modeling, within real-world issues like building efficiency, renewable energy systems, and climate change mitigation.

Energy literacy is broadly defined as the ability to understand energy systems, evaluate the implications of energy choices, and apply this understanding in personal, societal, and professional contexts (US Department of Energy, 2014). It is more than just knowing about different energy sources or how to improve efficiency. Energy literacy involves a comprehensive understanding of energy systems as a whole, including various factors such as socio-economic and environmental trade-offs, and making informed and responsible decisions (DeWaters & Powers, 2011; Cotton et al., 2015). These dimensions align closely with GreenComp's competence-based approaches to sustainability education (European Commission, 2022). GreenComp suggests that sustainability-related skills need to cover cognitive, socio-emotional, and behavioral aspects to truly make an impact. Despite these evolving demands, most STEM curricula remain discipline-specific and content-driven, often failing to address how foundational knowledge in physics, mathematics, or engineering connects to real-world sustainability challenges (UNESCO, 2017; Filho et al., 2018). As a result, graduates may be technically proficient but lack the broader systems thinking, policy awareness, and digital skills required to address the green transition effectively.

Furthermore, the ongoing digital transformation of society, including the big data analysis, and artificial intelligence, requires students to do more than just consume information. They must actively co-create solutions using digital technologies (Vuorikari et al., 2022). In energy-related fields, this means developing competences in modeling, interpreting sensor data, visualizing energy flows, and communicating findings. This calls for integrative learning approaches that merge sustainability, technical, and digital competences.

In response to these challenges, this study explores how energy literacy can be meaningfully embedded into existing STEM curricula through interdisciplinary teaching strategies and digital technologies, without requiring major structural changes. We begin with a document analysis and faculty interviews to assess current curriculum content and identify points of potential disciplinary intersections. Based on these insights, we develop an interdisciplinary teaching module that combines physics, mathematical modeling, and civil engineering practices. The module is grounded in project-based learning (PBL), chosen for its potential to foster system thinking, student engagement, and real-world problem solving (Barth et al., 2007; Corvers et al., 2016; Repko & Szostak, 2020).

Literature Review

To support the global shift toward sustainability and the green transition, a variety of frameworks have been developed, each emphasizing different aspects of sustainability education. These frameworks emphasize a broad range of knowledge, values, and skills essential for navigating environmental complexity and driving systemic change (Shephard, 2008).

The UNESCO (2017) Framework for Education for Sustainable Development promotes a holistic approach to education that aims to strengthen learners' abilities to respond to the challenges of sustainability through critical thinking, systems thinking, self-awareness and integrated problem solving. The framework defines eight key competences:

(1) Systems thinking
(2) Anticipatory thinking
(3) Normative competence
(4) Strategic competence
(5) Collaboration
(6) Critical thinking
(7) Self-awareness
(8) Integrated problem-solving

While on one hand this framework emphasizes dispositions and mindsets necessary for sustainability leadership content, it remains relatively high-level and conceptual, offering limited operational guidance.

The European GreenComp Framework (2022) further builds on UNESCO's foundation by providing a structured, actionable model of sustainability competences. It organizes 12 competences into four thematic areas:

(1) Embodying sustainability values (appreciating sustainability, supporting fairness, promoting nature),
(2) Embracing complexity (systems thinking, critical thinking, problem framing),
(3) Visualizing a sustainable future (future literacy, adaptability, exploratory thinking),
(4) Acting for sustainability (political action, collective action, individual initiative).

GreenComp offers concrete descriptors and can be adapted across all levels of education and training, making it particularly suitable for policy alignment and curricular development in European contexts.

These frameworks not only promote education for sustainability but are also in line with the broader goals of global citizenship. By developing skills like critical thinking, collaboration, and system thinking, we prepare learners to tackle global challenges that go beyond national borders. In addition, the increasing complexity of sustainability issues requires interdisciplinary and international collaboration, particularly in STEM fields where innovative problem-solving relies on a variety of expertise and open intercultural dialogue. Embedding Global Citizenship Education

within the framework of sustainability ensures that learners are equipped not only with technical knowledge, but also with intercultural understanding and ethical responsibility. Research by Chierichetti et al. (2025) further highlights the potential of both curriculum design and extracurricular activities in shaping students as global citizens. Integrating such opportunities into STEM education supports the development of socially responsible graduates, prepared to work in diverse teams and contributing to solving global sustainability challenges.

Energy Literacy

While UNESCO and GreenComp frameworks provide comprehensive visions for sustainability education, they remain relatively high-level and abstract in their guidance. One promising domain through which these competences can be applied in a tangible, disciplinary context is energy literacy.

The North American Association for Environmental Education (NAAEE, n.d.) provides a framework that focuses on environmental and energy education through a set of core concepts and best practices. The framework includes:

(1) Understanding energy sources and systems,
(2) Recognizing human impacts on the environment,
(3) Evaluating actions for environmental and energy sustainability.

The NAAEE approach emphasizes lifelong learning and real-world application, supporting educators in designing programs that engage learners in energy-related problem-solving and community action. However, its U.S.-centric policy grounding may limit its integration into higher education curricula.

DeWaters and Powers (2011) propose a three-dimensional model of energy literacy encompassing:

(1) Cognitive (knowledge about energy systems),
(2) Affective (attitudes and values toward energy use),
(3) Behavioral (capacity to take informed action).

This framework provides a holistic perspective on energy literacy, advocating for education that connects technical understanding with ethical responsibility and behavioral change. It is particularly valuable for developing comprehensive learning outcomes that go beyond factual knowledge. However, it lacks detailed competence progression levels and discipline-specific applications.

The US Department of Energy (2014) defines energy literacy as the ability to understand energy's role in the universe and everyday life and to apply that understanding in problem-solving and decision-making. It outlines seven essential principles:

(1) Energy is governed by natural laws
(2) Energy drives Earth's systems
(3) All living systems require energy
(4) Humans use various energy sources, each with costs and benefits
(5) Energy decisions involve multiple factors
(6) Societal energy use is influenced by numerous variables
(7) Energy choices affect quality of life

This framework offers a strong foundational structure for science-based energy education, making it especially useful for integrating into physics and engineering curricula. However, it does not include skill-level progression or interdisciplinary dimensions like policy, biodiversity, or circular economy, areas increasingly critical to the green transition.

Klemencic et al. (2025) propose a comprehensive competency framework tailored to natural sciences and mathematics education. Grounded in the context of the green transition, the framework aims to foster critical competences in energy literacy, sustainability, and biodiversity awareness. The framework organizes 12 competences into five thematic domains, each spanning three proficiency levels. Each level includes detailed descriptors to guide educators in curriculum development and to support assessment of student progress. Five thematic domains are the following:

(1) Systems Thinking of Energy Systems (Understanding systemic interactions in environmental and biological energy flows, recognizing cause-effect relationships, feedback loops, and long-term sustainability implications),
(2) Biodiversity (Understanding the role of biodiversity in ecological and energy systems, developing and implementing biodiversity management strategies across contexts),
(3) Resource Management Skills (Applying principles of resource conservation, circular economy, and life-cycle analysis, planning for efficient energy use and sustainable infrastructure),
(4) Technological Competence (mastering the fundamentals of renewable energy technologies and green innovations, designing and optimizing sustainable technical solutions, from materials to systems),
(5) Policies and Regulation Awareness (Understanding environmental and energy policy frameworks, developing strategies for green entrepreneurship and participating in policy design).

Inclusion of biodiversity and policy reflects a systemic view of sustainability aligned with the "triple planetary crisis" of climate change, biodiversity loss, and pollution. This competency framework was applied to students studying physics, mathematics, and those pursuing degrees in educational physics and educational mathematics at the University of Maribor (IICE 2025). Findings indicated that students generally align well with market requirements; however, there are gaps in their knowledge of policy and competencies related to biodiversity across all programs. Its structured progression across proficiency levels enables educators to

define measurable learning outcomes in sustainability domains often perceived as abstract, offering practical support for curriculum design and assessment.

While each of the discussed frameworks contributes valuable perspectives, a clear gap remains in integrating them into discipline-specific and actionable curricular design. This study draws particularly on the Klemencic et al. (2025) framework due to its alignment with STEM disciplines and its potential for guiding curriculum integration at both the cognitive and practical levels.

Aim of the Study

This study aims to explore how energy literacy can be effectively integrated into STEM higher education through interdisciplinary teaching approaches and digital technologies, without requiring major structural reforms. Drawing on the presented frameworks, we seek to operationalize these conceptual foundations into a concrete, competence-based educational intervention. The study specifically investigates:

1. To what extent energy literacy and sustainability competences are currently embedded in physics, mathematics, and civil engineering curricula.
2. How interdisciplinary connections across STEM disciplines can be leveraged to develop a cohesive and practical teaching module.
3. How project-based learning, supported by digital tools, can enhance students' understanding of energy systems, sustainability, and real-world problem solving.

By analyzing curricula, interviewing lecturers, and designing a project-based interdisciplinary module, this study contributes a pedagogical model for embedding energy literacy in STEM education, aligned with 21st-century sustainability and digital competence goals. While focused on the University of Maribor, the study offers a transferable model that can inform curriculum redesigns across European higher education institutions.

Methodology

Our study was conducted in three parts. First, we conducted in-depth analysis of relevant curricula documents of bachelor's study programs Physics (P), Mathematics (M) and Civil Engineering (CE) at the University of Maribor. The selection of study programs was informed by their foundational role in STEM education and their potential for cross-disciplinary integration. Additionally, researchers from those study programs collaborate within a pilot project at University of Maribor. Secondly, as teaching practices in classroom can differ slightly from written curricula, we interviewed professors teaching specific subjects. Finally, based on our findings, we developed a specific interdisciplinary teaching module.

Document Analysis

The curricula of three study programs were analyzed through document analysis and interviews with lecturers. Combining document analysis and interviews enhances the depth of research. To enhance transparency and replicability, the qualitative content analysis used a coding framework based on the key dimensions of energy literacy (US Department of Energy, 2014; DeWaters & Powers, 2011) and sustainability competence frameworks (European Comission, 2022; Klemencic et al. 2025). The coding framework was mapped against cognitive, behavioral, and policy-related domains, allowing for a systematic comparison between existing curricula and the targeted sustainability competences. The cognitive domain captures knowledge-based outcomes, such as understanding of energy systems and sustainability principles, the behavioral domain reflects practical application and problem-solving in real-world contexts, and the policy-related domain addresses awareness of institutional, societal, and regulatory dimensions of energy and sustainability. We selected relevant curriculum documents for analysis. First, we analyzed the list of graduates' competences for the Physics, Mathematics, and Civil Engineering Study Programs at the University of Maribor. This was followed by a document analysis of 18 courses: Numerical methods (M), Introduction to differential equations (M), Mathematical modeling (M), Mechanics (P), Electromagnetism (P), System Thinking (P), Oscillation and waves (P), Modern physics (P), Applied Physics (P), Thermodynamics (P), Environmental physics (P), Building physics (CE), Civil engineering materials (CE), Geometric modeling and descriptive geometry (CE), Timber structures (CE), Steel structures (CE), Foundation engineering (CE), and Concrete structures (CE). Representative courses were selected based on their relevance to energy-related topics and their potential to support interdisciplinary teaching. Each course was coded for explicit references to energy-related concepts using selected keywords: energy sources, energy conservation, energy efficiency, energy policy, climate change, sustainability, environmental impact, circular economy. We also search for implicit sustainability competences (e.g. systems thinking, critical thinking, ethical reasoning) and opportunities for interdisciplinary learning and the use of digital tools.

The course outline includes general information about the subject (course type, lecturer, hours), prerequisites, syllabus outline, readings, objectives and competences, intended learning outcomes (knowledge and understanding, and transferable/key skills and other attributes), learning and teaching methods, assessment, lecturer's references. The goal of the analysis was to determine the extent to which current curricula integrate energy literacy. Our focus was on syllabus outline, objectives and competences and learning outcomes. Two researchers independently coded each course and then compared results. Possible discrepancies were discussed until consensus was reached.

While document analysis cannot be influenced by the research process and remain consistent over time (Bowen, 2009), interviews offer firsthand perspective and can clarify ambiguities. Semi-structured interviews were conducted with professors, who lecture the above-mentioned courses. Participation was voluntary, and interviews were not audio-recorded in order to create more comfortable and open atmosphere. Detailed notes taken during the interviews were analyzed thematically using an

inductive approach. The interview protocols included the following questions relevant to this study:

> Q1. Do you include content from the field of energy literacy in the pedagogical process? If so, in what way?
> Q2. Is energy literacy included among the goals and competences? If so, in what way?
> Q3. Is the development of energy literacy foreseen among the study results? If so, in what way?

Interdisciplinary Teaching Module Design

Based on curricula analysis, we designed an interdisciplinary teaching module that connects the theoretical foundations of physics, mathematics, and civil engineering for students at the University of Maribor. The design process began by identifying a thematic focus that would provide meaningful contexts for all three disciplines. We selected energy-efficient building analysis, given its strong relevance to climate change mitigation, urban sustainability, and everyday energy use. Next, we outline connections to each discipline, to emphasize interdisciplinarity:

(1) Physics: Students explore the thermodynamics principles of heat transfer, conduction, convection, and radiation in the context of building insulation and envelope performance. Emphasis is placed on interpreting physical laws (Fourier's law) within applied systems.
(2) Mathematics: Concepts such as differential equations, partial derivatives, and numerical approximations are used in mathematical modelling of heat flow, optimization of insulation strategies, and interpretation of energy profiles over time.
(3) Civil Engineering: Students are introduced to civil engineering considerations, including material properties, structural thermal bridging, and regulatory standards related to energy efficiency. Energy audits are contextualized as multidisciplinary tasks requiring both measurement and interpretation.

Additionally, we incorporated digital technologies such as infrared cameras, analysis of measurements data and simulation software, as well as a collaborative platform to support interactive learning. As a pedagogical approach, we adopted project-based learning, a learner-centered method known to promote higher-order thinking, collaboration, and real-world problem-solving (Cörvers et al., 2016; Kurt & Akoglu, 2023).

Results

Integration of Energy Literacy in Curricula

We began by analyzing the list of graduates' competences of selected study programs. Our focus was on identifying how well energy literacy, sustainability, and green transition competences are integrated. The findings reveal a significant imbalance:

energy-related competences are notably underrepresented across all programs when compared to computational skills and digital literacy. Among the examined study programs, the Civil Engineering Study Program demonstrates the highest integration, with approximately 38% (8 out of 21) of its core competences aligning with energy literacy. The Physics Study Program follows with 33 % (7 out of 21), indicating some level of integration. In contrast, the Mathematics Study Program shows no alignment at all between its core objectives and energy literacy.

As the initial analysis focused solely on the key objectives and competences a graduate will obtain by completion of a study program, we proceeded with a more detailed document analysis of 18 individual courses to gain a deeper understanding of how energy literacy and sustainability are represented within the curricula. The analysis revealed that energy literacy is not explicitly addressed in most of the examined courses. For all three courses in the Mathematics Study Program, we identified potential opportunities to integrate energy literacy by applying theoretical knowledge to the problem-solving of authentic, energy-related issues. Tables 1, 2 and 3 present a summary of the findings for each study program, including direct excerpts from curricula in sections where energy literacy could potentially be integrated.

Table 1. Summarized findings of Curricula Analysis of Mathematics Study Program

Course	**Syllabus outline**	**Objectives and competences**	**Learning outcomes**
Numerical methods	/	/	Critical Thinking Skills (problem solving): solving more demanding numerical tasks and practical problems.
Intro to differential equations	Ordinary differential equations: … applications in geometry and physics Modeling changes with differential equations.	/	Critical Thinking Skills (problem solving): solving more demanding physical tasks and practical problems based on the acquired knowledge
Mathematical modeling	Modeling changes with difference and differential equations. Mathematical behavior of dynamic systems. Applications of math models in science and engineering.	Apply knowledge from other mathematical areas in analysis of practical problems. Gain experience in developing a mathematical model, useful in their future career	To deepen the knowledge of applications of mathematical modelling in research and practice. Direct applications in … numerous other social and natural sciences.

Source: own

Within the Physics Study program, few courses support the development of energy literacy through key knowledge areas such as energy, energy conversion and storage, particularly in courses Mechanics, Thermodynamics, Oscillations and Waves,

Electromagnetism, and Modern Physics (see Table 2). A more comprehensive focus on energy literacy is evident in only one course, Environmental Physics, offered as an elective. In this course, energy literacy is framed as a transferable skill, as reflected in the learning objective: *"The student is aware of the importance of protecting the environment and is ready to work on physics projects in the field of environmental protection."* This unit introduces students to physical processes in various environments, technical applications, energy sources, waste management, and eco-remediation techniques. This content directly supports the development of knowledge relevant to energy literacy and sustainable practices. Additionally, two compulsory courses, Applied physics and System thinking, offer opportunities to integrate energy literacy and sustainability. System thinking aligns with the GreenComp framework, emphasizing the importance of understanding complex system dynamics. In Applied physics, the focus is on transferring theoretical knowledge to real-world problem-solving, which supports the development of practical skills relevant to energy and sustainability.

*Table 2. S*ummarized findings of Curricula Analysis of Physics Study Program

Course	**Syllabus outline**	**Objectives and competences**	**Learning outcomes**
Mechanics	Kinetic energy and work, potential energy, conservative and dissipative forces, conservation of mechanical energy, conservation of energy.	Define a physical system, the elements in the surrounding that affect the system and qualitatively and quantitatively predict changes of the system	Use modern computer software for quantitative calculations and for plotting dependencies among variables at different values of parameters
Electro-magnetism	Capacitors, energy, semiconductors, superconductors, electric circuits, voltage sources	Students acquire basic theoretical knowledge in electromagnetism and can use the knowledge to solve problems with the use of mathematical tools.	Understanding basic processes in nature giving rise to electromagnetic phenomena and gained global approach to solving problems
Oscillation and Waves	Electro-magnetic waves: spectrum, source, radiation pressure, polarization.	/	/
Thermo-dynamics	Heat transfer Heat engines and second law of thermodynamics	/	Apply the principles of thermodynamics to analyze the phenomena associated with heat transfer Use modern computer software for quantitative calculations

Modern Physics	Atomic Nucleus. Models, radioactivity, nuclear reactions	Acquire basic theoretical knowledge in modern physics, use knowledge to solve problems with the use of mathematical tools.	Understanding of basic processes in nature and gained global approach to solving problems
Applied Physics	Application of physics in different fields of economy and everyday living	Solving real physical problems in different fields of activities and in applications	Recognizes opportunities to apply theoretical knowledge of physics. Plans and conducts transfer of theoretical knowledge. Connects theoretical knowledge of physics with contents of other research or professional areas. Understands the meaning of application of theoretical knowledge.
System Thinking	Structure, dynamics and evolution of natural, technical and social complex systems System Thinking and System Dynamics Modelling. Applications in Physics and in other fields: population dynamics, environmental systems, biological systems.	Transfer of using general methods for the analysis of physical systems to other fields, e.g., population dynamics, environment, biological systems	Implement methods for qualitative analysis of system dynamics for simple physical systems. Better communicate in the field of natural sciences. Effectively solve problems: problem solving with the modelling of systems dynamics
Environmental Physics	Physical processes and phenomena in different environments and technical applications Physics of energy sources Physics of dealing with waste	Students acquire knowledge that is necessary for complex understanding of physical phenomena and processes in environment. On different examples from natural or technical environments they understand importance and kinds of energy sources and energy transitions. They understand	Understands complex physical phenomena and processes in the environment, energetics, and waste management. Describe environmental systems, phenomena, and processes with physical models. Able to measure physical parameters in the environment and interpret the obtained measurements.

		different types of waste and how to safely transport and store them.	Analytically and numerically solves physical models of environmental systems.

Source: own

In the Civil Engineering Study Program, energy literacy is explicitly incorporated in the compulsory course Building Physics, which plays a central role in connecting foundational engineering principles with sustainable practices. The unit's learning goals state: *"…understanding professional procedures for improving energy efficiency in buildings, acoustics and lighting, and controlling moisture and noise*." The syllabus covers key topics such as thermodynamics, heat transfer, and heat behavior in building components. Although Building Physics is the only unit with an explicit emphasis on energy literacy, other courses offer indirect opportunities to support its development. For example, Civil Engineering Materials includes content on materials for insulation and protection, which are relevant to energy efficiency in construction. However, this potential is not fully realized, as the objectives and learning outcomes do not explicitly connect to energy or sustainability. Similarly, units such as Concrete Structures and Geometric Modeling and Descriptive Geometry develop essential engineering skills but lack direct references to energy-related competencies. This indicates that while the program includes valuable foundational knowledge, there is room to integrate energy literacy more systematically across the curriculum. Table 3 provides a summary of these findings, including curriculum excerpts and a mapping of relevant objectives and learning outcomes.

Table 3. Summarized findings of Curricula Analysis of Civil Engineering Study Program

Course	**Syllabus outline**	**Objectives and competences**	**Learning outcomes**
Civil Engineering Materials	Materials for isolation and protection.	/	Understanding of principles of material property determination and principles of material design for engineering applications Given a civil engineering material, to be able to select appropriate testing method.
Timber Structures	/	/	/
Steel Structures	/	/	/
Concrete Structures	/	/	Ability of structural analysis, design and assemble of single reinforced concrete structural elements.
Building Physics	Basics of thermodynamics Heat transfer Heat transfer in building components	Good understanding of heat and moisture transfer. Study related international standards and to learn professional best practices for improving energy efficiency	Explain the mechanisms of heat transfer and connect them into a structure. Qualitatively predict and quantitatively determine heat losses. Choose professionally suitable civil engineering solutions regarding heat transfer. Identify the reasons for excessive heat transfers
Foundation Engineering	/	Understand the philosophy of geotechnical design, design situations, ultimate limit states and serviceability limit states, determination of project loads and project bearing capacity in all types of	/

		foundation and other geotechnical structures	
Geometric Modeling and Descriptive Geometry	/	/	Use geometric modeling to present engineering information.

Source: own

In addition to document analysis, semi-structured interviews with professors were conducted to gain insight into actual classroom practices. In the Physics Study Program, energy literacy is integrated primarily through problem-solving activities. For instance, students engage in comparing energy outputs from different types of power plants in Mechanics, analyzing the efficiency of various heating, cooling, and engine systems in Thermodynamics, and evaluating modern "green" technologies, such as LED lighting, electric vehicles, and renewable energy sources, in Applied Physics. Modern Physics addresses nuclear fission and fusion with an emphasis on their relevance to energy production, while Environmental Physics highlights the environmental impacts of energy systems and the link between energy use and climate change. In the Mathematics Study Program, the unit Mathematical Modelling was identified as a key opportunity for integrating energy literacy, as it involves solving real-world problems that can include energy-related challenges. Within the Civil Engineering study Program, interviews revealed that energy literacy is partially included in Concrete Structures and Steel Structures, where students are expected to understand energy-related concepts and apply this knowledge in structural design. However, although energy issues are introduced during initial lectures, the instructional focus tends to shift toward material optimization, with limited sustained attention to energy efficiency or broader sustainability considerations.

The results of the curriculum analysis and interviews are summarized in Table 4, which compares the integration of energy literacy and related competences across the Physics, Mathematics, and Civil Engineering study programs.

Table 4. Summary of Energy Literacy Integration Across Study Programs

Study Program	Explicit Energy Content	Sustainability Competences	Interdisciplinary Opportunities	Digital Tools
Physics	Present in Applied Physics, Environmental Physics, System Thinking	Moderate – supports systems thinking	Strong – links to environmental contexts	Moderate (simulation, programming, lab tools)
Mathematics	None	Low – mainly cognitive dimensions	Weak – abstract focus	Limited use (modelling tools)
Civil Engineering	Strong in Building Physics	Moderate – focused on efficiency, materials	Strong – project-based potential	Moderate (design tools)

Source: own

Interdisciplinary Teaching Module "Optimizing Energy Efficiency in Buildings"

The teaching module is designed for bachelor's degree students in STEM fields and is structured into five sessions, each lasting two hours: (1) Introduction to Energy in Buildings, (2) Thermodynamics and Modeling, (3) Measurement and Data Collection, (4) Simulation and Optimization, (5) Presentation and Reflection. The proposed teaching method is project-based learning, implemented through collaborative group work. Table 5 outlines the planned student activities alongside the corresponding roles and responsibilities of the instructor – lecturer.

Table 5. Sessions Overview

Session	Students Activities	Lecturer Role
1	- Learn about key thermodynamics principles - Discuss the importance of energy in buildings (analyze a case study) - Formation of project teams - Brainstorm initial ideas	- Lecture on project context (theoretical background and) - Present project goals - Facilitate discussion - Assign teams - Help to define research question
2	- Learn about heat transfer types - Apply Fourier's law and basic differential equations - Calculate heat loss - Discuss real-world relevance	- Lecture on physics and mathematics principles - Support application in building context - Guide students through modelling tasks
3	- Use IR camera and sensors - Measure building envelope (windows, walls, etc.) - Log and interpret temperature data	- Demonstrate tools - Ensure safety - Supervise measurements - Guide data organization and analysis
4	- Input data into simulation or modeling tool - Explore effects of different materials or insulation	- Provide instructions on tools/software - Support modeling - Guide cost/sustainability analysis

	- Plan improvement strategies	
5	- Present findings and design solutions - Engage in peer feedback - Reflect on interdisciplinary learning	- Facilitate presentations and feedback - Assess learning outcomes

Source: own

Detailed Sessions Plan

The teaching module begins in Session 1 with an introduction to energy use in buildings. Students learn kex thermodynamic principles, focusing on heat transfer, insulation, and energy loss, while exploring the importance of energy efficiency through group discussions. They form project teams and brainstorm possible factors that influence building energy efficiency. Each group defines a specific research question, for example "How can we improve building efficiency, if the building's exterior envelope cannot be changed?".

The second session focuses on mathematical modelling. Students study heat transfer mechanisms, use formulas for heat conduction, apply derivatives and build basic models. Depending on their prior knowledge, they may also work with transient heat transfer described by Fourier's law using partial differential equations.

Session 3 shifts to hands-on data collection. Students use infrared cameras and sensors to measure surface temperatures of walls, windows, and insulation points, aiming to detect so-called hot spots, thermal bridges and areas of heat loss. They log, organize, and begin to interpret the data to identify thermal weaknesses in the structure. Various software options can be used for analysis; for example, the FLIR Thermal Studio software provides a user-friendly platform when using FLIR infrared cameras.

In Session 4, students build simple simulation models using digital tools to evaluate different insulation materials and energy solutions. Based on their programming skills, they may use digital tools, such as Excel, Python, C++, Wolfram Mathematica, or AI-based applications. In this session, it is important they analyze the environmental and economic impacts of their proposed improvements and begin preparing their final design strategies.

Finally, in the last session, each team presents its findings and solutions, supported by data and simulations. The session includes peer feedback, group reflection on interdisciplinary learning, and a discussion on how the knowledge gained applies to real-world sustainability and engineering challenges.

Objectives, Competences and Learning Outcomes

After successful completion of the teaching module, students will be able to (1) analyze the energy balance of a building using thermodynamic principles, (2) apply mathematical tools such as differential equations and derivatives to model heat flow, (3) evaluate and suggest improvements to building design for better energy efficiency (4) use tools like infrared cameras and simulation software to collect and interpret data, (5) understand ecological and economic implications of energy inefficiency, and (6) communicate findings through technical presentations or reports. Key competences developed are the following:

- Critical thinking and problem-solving
- Systems thinking and sustainability awareness
- Digital literacy and data analysis
- Interdisciplinary collaboration

Assessment

We suggest the following assessment presented in Table 6, with which students are acquainted beforehand.

Table 6. Assessment Rubric

Criteria	**Need improvement**	**Satisfactory**	**Good**	**Excellent**
Scientific and mathematical accuracy	Significant misconceptions	Conceptual understanding present	Minor errors	Accurate modelling and correct use of physics/math tools
Practical application and design	Lacking real-world relevance	Generic or partially applicable	Reasonable and realistic	Creative, feasible, sustainable
Use of tools and data	Poor integration of tools	Basic usage	Some support needed	Effective use
Collaboration and presentation	Disorganized or unclear	Adequate	Mostly clear, some improvements need	Clear, engaging, well-structured

Source: own

Discussion

The curriculum analysis revealed varying degrees of energy literacy integration across the three examined STEM programs. The Civil Engineering Study Program demonstrates the most explicit alignment, particularly through the Building Physics course, which directly addresses energy efficiency in buildings. However, the program still tends to prioritize material performance and structural optimization over broader sustainability considerations. Institutional commitment to sustainability and curriculum innovation is essential for scaling such initiatives, suggesting that top-down support may significantly enhance adoption.

In the Physics Study Program, while energy literacy is not always explicitly named in course objectives, students develop key knowledge and skills essential to it, particularly in the System Thinking, Applied Physics, and Environmental Physics courses. These provide students with a comprehensive understanding of energy systems, encourage interdisciplinary thinking, and explore real-world applications such as energy efficiency technologies, power generation methods, and environmental

impacts. This suggests that the Physics Study Program already offers a strong foundation for energy literacy, albeit under different conceptual framings.

In contrast, the Mathematics Study Program lacks direct references to energy or sustainability. Nevertheless, courses such as Mathematical Modelling offer valuable opportunities for integration, particularly through applied problem-solving tasks that can be adapted to energy-related challenges. Recent studies confirm that mathematics education often emphasizes abstract modelling rather than real-world applications (Vasquez et al., 2023, Makramalla et al., 2025). In higher education, study by Naidoo (2023) shows that integration of digital tools and authentic contexts can enhance sustainable mathematics embedding and critical thinking.

These findings confirm earlier observations (Barth et al., 2007; Filho et al., 2018) that sustainability competences in higher education often remain implicit or fragmented rather than systematically embedded. Similar to Corvers et al. (2016), our results highlight that rigid curricula and limited institutional incentives can restrict interdisciplinary collaboration. At the same time, this initiative in Physics and Civil Engineering supports Green Comp's (European Comission, 2022) argument, that STEM disciplines can provide entry points to integrate sustainability competences. The document analysis across three programs also supports findings of DeWaters and Powers (2011) that depending on disciplinary focus development of different aspects of energy literacy is uneven. These patterns suggest that fostering energy literacy requires not only curricular alignment but also professional development for lecturers and institutional support for interdisciplinary collaborations.

Overall, the findings underscore the importance of recognizing and building on existing disciplinary strengths. Energy literacy, as defined by current frameworks, is a multidimensional competence that includes technical understanding, systems thinking, ethical reasoning, and the ability to act. The interdisciplinary teaching module proposed in this study leverages these principles by connecting disciplinary content with real-world applications, supported by digital tools and collaborative learning. While the module has not yet been piloted, its implementation is planned for the upcoming academic year. Unlike previous research that has primarily examined sustainability integration from a policy or curricular design perspective, this study provides an operational model for embedding energy literacy directly within existing STEM courses through interdisciplinary and digital approaches. The pilot will adopt a mixed-methods evaluation, combining quantitative pre- and post-module assessments with qualitative feedback from student reflections and focus groups. Evaluation will focus on measuring students gain in energy literacy using instruments aligned with the Klemencic et al. (2025) framework. The outcomes of this pilot will guide the refinement of the module and contribute to institutional strategies for scaling interdisciplinary sustainability education.

Conclusion

This study demonstrates that energy literacy can be meaningfully embedded into STEM higher education through interdisciplinary teaching approaches and without the need for extensive curricular reform. Curriculum analysis and faculty interviews across Physics, Mathematics, and Civil Engineering study programs revealed varying degrees of alignment with energy literacy competences. Notably, Physics courses such as System Thinking, Applied Physics, and Environmental Physics support the development of relevant knowledge and skills, while Civil Engineering includes explicit content in Building Physics. Furthermore, Mathematics presents potential for integration, particularly through applied modeling in courses such as Mathematical modelling.

Our findings resonate with gaps identified in other disciplines. For example, a recent content analysis of studies on sustainability leadership in police education (Fagerland et al., 2025) revealed that only two out of eight studies directly addressed core sustainability leadership competencies or policy awareness. This highlights a broader challenge in higher education: sustainability-related policy knowledge remains underdeveloped even in fields where they are crucial.

The findings of this study underscore the importance of pedagogical redesign, particularly project-based learning and digital tools, in supporting systems thinking and interdisciplinary application (Barth et al., 2007; Kurt & Akoglu, 2023). The teaching module proposed in this study reflects these strategies and aligns with established sustainability frameworks, including GreenComp (European Commission, 2022) and the Klemenčič et al. (2025) framework, which provides discipline-specific descriptors across cognitive, behavioral, and policy-related domains relevant to the green transition. Effective integration of sustainability into education relies more on the redesign of existing pedagogical structures than on adding new content, as it facilitates connections between disciplinary knowledge and real-world sustainability challenges.

However, this study is limited by its focus on two faculties within a single university, which may restrict the generalizability of the findings to other higher education contexts with different curricula or national policy frameworks. Additionally, the focus is on three specific study programs, Physics, Mathematics and Civil Engineering. Although these are representative STEM disciplines, they do not capture the full diversity of approaches in areas such as computer science, chemistry, biology or environmental engineering. Future research should include comparative studies to assess the applicability and the transferability to other STEM disciplines and combine qualitative and quantitative measures of students learning once the module is piloted.

From a methodological perspective, this study is also limited by its reliance on documents analysis and faculty perspectives, as students' perceptions were not examined. This restricts the ability to assess the actual impact of current teaching practices on the development of energy literacy competences. Longitudinal studies would also be beneficial in determining whether such interdisciplinary approaches have long-term effects in energy literacy and sustainability competences development. Furthermore, future research should explore how participation in

such interdisciplinary modules influences students' career readiness and their engagement with sustainability beyond academia.

To support meaningful integration, universities could establish cross-faculty teaching clusters, shared digital repositories of sustainability-related case studies, and targeted professional development programs in interdisciplinary pedagogy and digital competence. Higher education institutions can support such transformations by offering professional development for educators in relevant topics and by enabling collaborative, interdisciplinary learning. By embedding energy literacy as a transversal competence, STEM education can not only align with global policy frameworks but also enhance its societal relevance in addressing complex energy challenges and advancing sustainable development (UNESCO, 2020; Cotton et al., 2015). In doing so, higher education can play a pivotal role in preparing graduates who are not only technically proficient but also critically aware, ethically responsible, and ready to address the complex energy and sustainability challenges of the 21st century.

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Examining the Levels of the Faculty of Education Students' Possession of the Values in the European Living Values Education Program: Yildiz Technical University Case[1]

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The socialisation process that starts in the family continues with educational institutions. As individuals remain in education, they gain social values and contribute to social continuity. Thus, the individual becomes a member of that society. Social values are formed through the filter of a long life. Values are not preferred according to taste but principles of life that provide a more or less definite and systematic vital order that enables the individual to interact with their environment. As its operators, the school and the teacher play an essential role in adopting these values. Due to the social role of the teaching profession and its power over the individual, teachers are expected to know and possess the national and universal living values that are valid in that society. As the centre of deliberate acculturation, the school equips children from different socio-economic and educational backgrounds with socially approved knowledge, skills, habits, attitudes, and values. It equips them with the requirements of social life. While educating individuals, educational institutions also contribute to social continuity and cultural richness. This research examines the level of Yildiz Technical University (YTU), Faculty of Education students' possession of the twelve (12) values in the European Living Values Education Programme. In this respect, the research is a quantitative study of survey type and was conducted with 474 undergraduate students who agreed to participate in the study. According to the statistical analysis of the data obtained from the research, students assessed their level of value based on their perceptions. The findings revealed significant differences in the total value scores among YTU, Faculty of Education students. Specifically, female students were found to have higher value scores compared to male students. Students in the Science Teaching and Turkish Language Teaching departments had higher value scores than those in other departments.

Keywords: education, value, value education, living values

Introduction

Educational efforts aim to ensure the healthy and efficient adaptation of growing children and young people to society (Varış, 1991, p. 5). In the realisation process of this adaptation, the interests and abilities of individuals are developed through education and human behaviour is changed to align with social approval. In this sense, education is "*the process of intentional acculturation*" (Ertürk, 1984, p. 10). Young

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individuals born into dynamic cultural values produce new values based on the expectations and demands of contemporary conditions by giving continuity and flexibility to these values through education. In this sense, beyond providing individuals with existing knowledge and skills, education also ensures the continuity and development of society by realising cultural reproduction. In doing so, education has to prevent the destruction of existing values to produce new values and to educate the individuals required by the age (Varış, 1991, p. 5; Willemse et al., 2005).

These values, which students acquire in the family and educational institutions, radically affect students' behaviours, perspectives, feelings, and thoughts and teach individuals how to behave in social life (Moore, 2010, p. 45; Robb, 1998). Value means "a set of standards that constitute any individual's judgement of people, situations, ideas and actions as good-bad, desirable-undesirable" (Halstead & Taylor, 2000, p. 169; Willemse et al., 2005). In short, value is "the tendency to prefer a certain situation over another" (Erden, 2011, p. 56). Thus, young individuals distinguish between good and bad, right and wrong, through social rules and traditions that are important to them and to form a set of criteria in line with their moral principles over time (Beill, 2003, p. 14). Therefore, value is a set of criteria that gives meaning and importance to culture and society. In this respect, values are the most important social control mechanisms in social life. In recent years, social, political, cultural and especially economic changes in the world have produced new values. One of these is globalisation. In the current era, globalisation has been used with concepts such as "new world order, post-modernism, localisation and neoliberalism" (Sönmez, 2002, p. 1).

Therefore, globalisation is felt in various areas, from economy to politics and social policy to culture. It can be said that globalisation causes the spread of national and universal values adopted by societies worldwide, the disappearance of differences in integrity and harmony, and the world becoming a global village. In such a structure, education is expected to be structured to strengthen national and universal values (Oktay, 2001, p. 22; Schlechty, 2006). For the realisation of this expectation, schools and teachers gain importance. Therefore, families and schools should find a way to help the individual effectively acquire the values of vital importance for the individual and society. In this process, schools and teachers, who are the operators of the school system, have significant duties (Yazıcı, 2006, p. 500).

According to the theories of modernisation through education, industrial societies have transformed into modern societies by changing their traditional structures and values. In this transformation process, modern schools have assumed essential responsibilities (Eskicumalı, 2003, p. 17) because schools are the living spaces established to provide the young individuals of society with cultural, social, ideological, economic and psychological values that the education system accepts as desirable characteristics (Senemoğlu, 2007; Oktay, 2001, p. 23). Therefore, schools, as educational institutions, are responsible organizations for these values (Özdemir, 2007, p. 185; Schlechty, 2006). With these characteristics, schools are obliged to change the individual's behaviours and provide new behaviours to meet the changes occurring in the individual's environment. According to Schweisfurth (2002), schools are essential in developing citizenship awareness. According to Cipani (2008), the education and training process comprises professional and personal values, which teachers consciously or unconsciously carry into the classroom.

The Turkish Language Association (TDK) defines the term value as "the totality of material and elements that cover a nation's social, cultural, economic and scientific values" (sozluk.gov.tr). In some Turkish dictionaries, the concept of value is defined as "the quality that determines the importance of objects and events for a society, a class or a person" or "an object or event that is important for a society, a class or a person" (Püsküllüoğlu, 2010). Humans are social beings. For this reason, they must follow certain rules to find a place in the society. Most of these rules, which are accepted and adopted by the generality of the people who make up the society, constitute social values. For this reason, the subject of values falls within the scope of many disciplines dealing with people, and each of these disciplines makes quite different definitions of the concept of value (Yalar & Yelken, 2011). The level of teachers and prospective teachers who carry values to the classroom is essential. To provide children with fundamental values in educational institutions, teacher candidates should first be aware of their values. For this purpose, it is considered necessary to know the level of student groups who will be teachers in the future to have the living values in the European Values Programme to update the programmes of the faculties of education and to meet students' needs who will be teachers bearing these values.

Living Values

Living Values Education (Living Values Education, 2004), a global movement supported by UNESCO to create a culture of peace, prioritises twelve personal and social values. These values are Cooperation, Freedom, Happiness, Honesty, Humility, Love, Peace, Respect, Responsibility, Simplicity, Tolerance and Unity.

Cooperation: Cooperation is any kind of power union to achieve common goals, the effort of everyone to participate in the work by putting themselves forward, or the state of providing common benefits from human relations. Most of the existing problems in our world are of human origin, and human cooperation is mandatory to solve these problems. As a Turkish proverb suggests, one hand has the power, and two hands have a voice. Young people need to be voluntary and open to cooperation in dealing with difficulties arising from everyday problems (Thomas, 1998). Cooperation stands out as a fundamental element of social relations. It is also important for completing projects, sharing knowledge and experience, and combining various skills and abilities. At the same time, the ability to produce interdisciplinary solutions also emerges due to the development of this value. Cooperation, which helps people to reveal their potential by allowing them to work together, contributes to the development and welfare of society by requiring a collective effort. Since everyone has a different background and perspective, a broader perspective is obtained, and it is possible to achieve more effective results. Effective communication stands out as a process based on trust and mutual understanding. For these reasons, cooperation is indispensable for success. ***Freedom:*** Freedom is the state of thinking and acting without denying the existence and thoughts of others by balancing truths with responsibility and choices with conscience. Therefore, freedom is not considered a state of unlimited action but as freedom of expression, freedom of movement (free movement of labour), freedom of enterprise (freedom of establishment), and free

movement of goods and capital within defined limits. The European Union defends social and political freedom as well as economic freedom. Human rights and freedoms constitute the fundamental value and belief system of the European Union (Novitsky, 2019). It allows people to express their opinions and act freely. This value requires conformity with the principles of truth and the limitation of choices by conscience. Freedom includes the right to think and express one's opinions freely without denying the existence and opinions of others. People can discover themselves, develop ideas, and contribute to society's progress through freedom. However, the misuse of freedom or excessive demands for freedom can disturb social peace or violate the rights of others. Therefore, freedom should be balanced with responsibility and conscience and exercised in consideration of the rights of others. ***Happiness:*** Happiness is a continuous or momentary state of well-being and peace arising from one's self-sovereignty. A person's happiness is related to being mentally, emotionally, and physically balanced. Happiness positively impacts an individual's life by providing a sense that life is meaningful and enjoyable, in other words it is considered as well-being (Sechel, 2019; Easterlin & O'Connor, 2022). ***Honesty:*** Honesty is defined as being realistic and consistent with oneself and others, as well as not lying, cheating, or being dishonest. It can also be defined as "the matching of thought with reality". Honesty lies at the basis of relationships, whether individual or social. Being honest helps people to be at peace with themselves and to behave honestly towards themselves (Dieckmann et al., 2016). ***Humility*:** Humility can be defined as knowing that everything that does not belong to us is left as an inheritance. In Turkish, modest is used in the same sense. Humility requires being away from exaggerations and ostentation (Stefanacci, 2020). We should not exaggerate what we have. Humility is an understanding, a way of life. Humility helps an individual maintain a balance between people and set an example for others through humble behaviour. Therefore, it motivates other people while making a person feel valuable and important. ***Love:*** It is the unconditional acceptance of ourselves and others. Love is the value that gives meaning to human existence. The presence of love lies at the basis of a relationship and is essential for the positive progress of any association. It encourages us to act with kindness, generosity, and tolerance. ***Peace*:** It is possible to define peace as "the state of living in harmony with internal and external stimuli by being aware of them" (Fabio & Tsuda, 2018, p. 2). ***Respect*:** Respect can be defined as a state of acknowledgement or acceptance of our own and others' differences or an unconditionally favourable opinion that creates an atmosphere of trust. Respect for others requires unconditional acceptance (Yüksel-Şahin, 2010, p. 37). While respect helps an individual to feel their value and be accepted, it also enables society to act together. A respectful society provides the necessary conditions for the happiness and welfare of individuals, which is an important goal for society. ***Responsibility:*** It is possible to define responsibility as a set of expectations attributed to individuals living alone or in a social order. Organising various social and cultural activities at school is necessary to give individuals a sense of responsibility (Yeşil, 2003, p. 52). The ability of young people to act with a sense of responsibility and gain skills depends on meeting basic principles and values in the education process that takes place in the family, environment and school process (Özgüven, 2000, p. 25; Özdemir, 2007, p. 196). ***Sincerity (Simplicity):*** Simplicity is defined as tolerance, "the state of tolerating

everything as much as possible by meeting everything with understanding, permissiveness, tolerance" (TDK, 2010). Sincerity is a fundamental value in human relations and forms the basis of successful relationships. ***Tolerance:*** Tolerance is "the state of meeting everything with understanding" (TDK, 2010). Tolerance helps to reduce negative attitudes such as intolerance, discrimination, and violence by strengthening the sense of understanding and solidarity among individuals. Therefore, tolerance is an important virtue with positive consequences in human relations and social life. **Unity** is "the willingness of individuals to be together with other individuals, to live together and to act together". It enables people to prioritise the general benefit of society rather than their interests. In the absence of unity and solidarity in society, conflicts, divisions, and the growth of problems are inevitable. For this reason, "unity" has been adopted as a living European value, recognising that the problems in the member states of the European Union can only be overcome if the member and candidate countries of the European Union act together.

Society is a group of people who have come together in a natural environment with definite boundaries to realise their shared goals. They are in cooperation and solidarity, bound by standard rules that have survived through the filter of time. *Values* are among the cultural elements that transform a group of people who have come together through such a process into a strong society. Values are one of the artistic elements filtered through the historical process and enable people to live together as a community. *Values are one of the* leading teaching objectives of the "socialisation of young individuals". Education is a lifelong phenomenon for human beings and continues inside and outside the school (Varış, 1991, p. 13). Although individuals acquire fundamental cultural values and necessary knowledge in the professional field during their education and school life, they have *to integrate* the new values emerging in parallel with the needs of the age *with their national values* and acquire new knowledge in the professional sense while continuing their lives in the society. In the 20th century, significant developments have occurred in many fields concerning human beings. Science, technology, industry, and economic developments have made considerable social changes. Advances in the technical field have led to rapid social transformations and several social-cultural problems. One of these social-cultural problems is *the* "*value crisis*".

The Importance of Teaching Profession in Terms of Values

Values guide people's attitudes and behaviours. Hence, their decisions limit behaviour and help to predict how people will react to the situations they encounter (Bakioğlu & Tokmak, 2009, p. 65). In terms of the socialisation process, individuals need to internalise national and universal values, in other words, to transfer them to their lives. Because one of the essential elements that hold societies together is shared values. Children learn the first fundamental values from their family and close environment. Then, the education process begins for the individual. Here, the student who encounters the teacher acquires knowledge, skills, habits, and values that are useful and necessary for them. The qualities needed for the individual are thus completed in educational institutions thanks to the teacher. Humans are the only creatures on this planet who can pass on what they know to their children through

education. Culture is the heritage that humans pass on to the next generation. As the only creature that transmits culture, humans transfer their experiences, knowledge, thoughts, beliefs, pleasures, pains, and values to other people in various ways. Due to this essential feature of human beings, culture and cultural elements are transferred to the next generation. This practice is still valid.

Cipani (2008) argues that the education and training process is complete with professional and personal values and that teachers carry them into the classroom with or without realising it. Cangelosi (2000) states that some individual characteristics may overlap with professional values. To provide children with fundamental values in educational institutions, it is essential that students who will be teachers are aware of their values. Teaching is "a specialised profession that takes over the state's *education, training* and *related administrative duties"* (Erden, 2011, p. 156). The teacher, whose main task is to ensure the student's socialisation and transfer the social culture to the student, must also know the cultural characteristics of the society in which they live to fulfil this task successfully. Teachers are liked and respected by all segments of society since the children of all segments need their light; children and young people cannot realise themselves without a teacher. Everyone needs a teacher in the process of finding themselves and being themselves. The fact that members of this professional group are qualified in terms of science and equipped with values in terms of culture provides both individual and social benefits.

The famous educators in history have answered the question, "*What should be the goal of education?*" by emphasizing the development of "moral character/virtue". For education to achieve this ultimate goal, schools must be able to influence and change the new generation's values, habits and social behaviour. When psychologist Thomas Lickona (1991) responded to the question "It is important to raise good people, but how to do it?" he said that "a planned effort" for character/value education is necessary for "the cultivation of the virtues required to be a good person". However, it is not enough to say that raising good people is central to education. Knowing how this is done and how goodness is defined is essential. In the face of the negative situations brought about by age, schools must be able to show their students options for making good choices and, at the same time, provide strategies for making these choices. Bowie and Morgan (1962, p. 341) conducted a study on fifty teachers using "The Allport-Vernon-Lindzey Values Scale" to determine the extent and nature of their value systems. Their study examining personal values and teachers' behaviour found that personal values affect teachers' behaviour, and there are differences between teachers in this respect.

According to Day (2002), the teaching profession is based on the teaching of values. Values are the regulators of society's social life. These unwritten values are beliefs that determine individuals' relationships with each other and their environment. Value is an individual's tendency to prefer certain situations about other individuals (Minor et al., 2002; Hofstede, 1991) or a different attitude, a permanent belief preferred according to the way of making sense of life (Rokeach, 1973). Value is the tendency to choose a particular situation over another (Erdem, 2003, p. 56). Dewey states that values are a part of social life; therefore, they are acquired by living in society (Gutek, 2001, p. 17; Minor et al., 2002). Thus, values are formed due to the interaction of the individuals who make up the society, giving direction to behaviours,

attitudes, beliefs, and habits. *As a result*, the teaching profession and values are inseparable.

Education and Values

It is essential to examine the intersection of education and values in Europe, considering the various initiatives and policies that influence educational practices and the transmission of values in the European context. Osler's (2020) work analyses policies related to education and migration on issues of human rights and racial justice, emphasising the influences on European standards and policy frameworks. This study offers insights into how these policies can integrate values related to social justice and economic justice into educational settings.

Komalasari and Sapriya's (2016) study aims to strengthen students' citizenship dispositions by discussing the use of Living Values Education (LVE) in educational materials. This approach is necessary for raising individuals with ethical foundations by focusing on values such as peace, love, tolerance, honesty, and cooperation. By integrating such values into educational materials, institutions can contribute to developing responsible and conscientious citizens.

The work of Jónsson and Rodríguez (2019) highlights the shift towards emphasising personal characteristics, values, and skills in European democratic education. This emphasis highlights the importance of instilling values and developing democratic competencies in line with democratic principles.

Living values education in Europe encompasses various principles. These principles focus on social justice, civic responsibility, democratic competencies, and intercultural dialogue. Isac et al.'s (2021) research addresses the different challenges of the European student population by examining citizenship norms among native and migrant students. It emphasises the importance of inclusive citizenship education in promoting shared values.

Education plays a crucial role in shaping individuals' values and beliefs, especially in the field of values education in Europe. Incorporating values such as peace, love, tolerance, honesty, humility, cooperation, and unity into educational materials is essential for raising responsible and ethical citizens (Komalasari & Sapriya, 2016). By integrating these values into the curriculum, academic institutions can contribute to developing individuals with a solid moral foundation, which is vital for promoting social responsibility and active citizenship.

García et al.'s (2019) research examining Andalusian university students' perceptions of their European identity reveals a general awareness of European partnerships and a utilitarian view of the EU. While students exhibit a supranational orientation, there may be a lack of a clear understanding of European institutions or a distinct European identity. This underlines the need for further research on how educational institutions can enhance students' understanding of European values and identity.

Jagielska-Burduk and Stec (2019) discuss the Council of Europe, Cultural Heritage, and Education Policy in a broader European context. They emphasize the importance of preserving identity and seeking a common core within European

cultural heritage. This emphasises the role of educational initiatives in developing a shared sense of identity and heritage among European societies.

Regarding educational values, Altınyelken (2021) emphasises the importance of critical thinking and reflection on justice, equality, and democratic participation. Encouraging students to evaluate different points of view critically is essential to promote open-mindedness and respect for other points of view, which are crucial elements of European living values education.

Consequently, including values in the education programmes significantly influences individuals' ethical frameworks and fosters a sense of social responsibility and active citizenship. By incorporating values such as peace, tolerance, critical thinking, and democratic participation into educational practice, institutions can help develop individuals who embrace Europe's living values.

Putting these perspectives together, it becomes clear that living values education in Europe covers many principles, from social justice and democratic competencies to intercultural understanding. Universities play an essential role in shaping students' values and attitudes, thus contributing to developing a coherent European identity based on shared ethical foundations.

Purpose and Importance of the Research

This study aims to determine the level of YTU, Faculty of Education students' possession of the values in the "*European Living Values Education Programme*". The effective acquisition of values can be realised through teachers' experiences since they are the operators of the education and training process, and these students will be teachers in the future. For this reason, it was deemed essential to investigate the level of possession of the values in the "European Living Values Education Programme" by the students of the Faculty of Education, according to their perceptions and in terms of some personal variables.

Research Problem

This research examines the living values of YTU Faculty of Education students who will be teachers. For this reason, the study's main question is: "*What is the level of possession of European Living Values for YTU Faculty of Education Students?*" The following research questions were formulated to get to the main question.

Research Sub-Problems

1. What are the levels of living values possession for YTU, Faculty of Education students?
2. Do the levels of living values possession for YTU, Faculty of Education students vary according to the gender variable?
3. Do the levels of living values possession for YTU, Faculty of Education students vary according to the region they attended primary school?
4. Do the levels of living values possession for YTU, Faculty of Education students vary according to the region they attended middle school?

5. Do the levels of living values possession for YTU, Faculty of Education students vary according to the region they attended high school?
6. Do the levels of living values possession for YTU, Faculty of Education students vary according to the department they study?

Method

Research Model

Statistical analyses were used to determine whether the level of YTU Faculty of Education students' perception of the "Living Values" in the "Values Questionnaire" differs according to the variables of "Gender", "Class", "Department", "Primary School", "Secondary School" and "High School" region. The research is descriptive in this respect, and as a method, the *single survey* model was used, since this survey model is "*based on depicting the existing situation as it is*" (Karasar, 2005, p. 79). Survey models provide a quantitative or numerical description of the general population's tendencies, attitudes or opinions through studies on a sample selected from a population (Creswell, 2013, p. 155). A single survey, one of the survey models, is a research model conducted to determine the occurrence of variables individually or in quantity. In this model, the variables belonging to the event, item, individual or subject of interest are to be described (introduced) separately (Kıncal, 2010, p. 110).

Population and Sample/Study Group

The population of this study consists of "*undergraduate students*" of Yıldız Technical University (YTU), Faculty of Education. The number of undergraduate students of YTU, Faculty of Education is around two thousand five hundred and ninety-three (2590). The study group aimed to reach at least 10% of the current students from all levels and fields studying to be teachers *in* the 2023-2024 Fall and Spring semesters at YTU, Faculty of Education. The data collection tool's link was sent to all students of the Faculty of Education in the invitation email and the participation is based on a "*voluntary*" basis. Five hundred and thirty-one (531) undergraduate students from the Faculty of Education volunteered for the study. Since some of the participants filled in some personal data in the *data collection tool* and elimination process took place for the data to be used for the study. As a result, the research was conducted with a total of four hundred and seventy-four (474) students from different classes and departments. Of these, (**1**) fifty-three (**53**) were pre-school teaching, (**2**) fifty-two (**52**) were primary teaching, (**3**) fifty-three (**53**) were English language teaching, **(4**) fifty-two **(52**) were social sciences teaching, **(5**) fifty-two **(52**) were mathematics teaching, (**6**) fifty-two **(52**) were computer and instructional technologies teaching, **(7**) fifty-two **(52**) were science teaching, **(8**) fifty-four **(54**) were Turkish language teaching, and **(9**) fifty-three were psychological counselling and guidance students. Four hundred and seventy-four (474) students who voluntarily participated in the study constituted 18.27% of the total population, considered an appropriate sample/study group. When numbers are analysed it can be seen that the majority of the participants are first-year students.

Data Collection Tool

The researchers created the "Values Questionnaire Form" and "Student Personal Information Form (SPIF)" to collect the necessary information for the study. The "*Values Form*" was prepared by converting the twelve values in *the* "*European Living Values Education Programme*" into a scoring scale. The students were asked to rate their perception of possessing these values between one (1) and five (5). The lowest possible score was twelve (12), and the highest was sixty (60). To minimize the variability in how students interpret abstract values, the questionnaire was accompanied by short, student-friendly definitions based on the original Living Values Education Programme. This helped ensure a shared understanding across participants.

Student Personal Information Form: The "Student Personal Information Form" obtained personal information about the students. This form was used to collect students' related information, gender, primary school, secondary school, high school and department. Ethical approval for the form was obtained on 02.06.2022 with registration number 2022.06 from the Social Sciences and Humanities Research Ethics Committee.

The "Living Values Education Program (LVEP)" was developed as an educational project by the Indian Brahma Kumaris Educational Organization in 1995 for the 50th anniversary of the United Nations and dedicated to the United Nations. Since then, "living values education", which is supported by UNESCO, has been included in education programs in many countries (Haryati & Suciptaningsih, 2020). The aim of living values education programs is to enrich individuals' interpersonal social-emotional skills (Cooper, 2014; Peterson, 2020). Today, values education is handled in cooperation with school and family (Lovat et al., 2009; Revell & Arthur, 2007). In this process, teachers play an important role by transforming programs into educational activities to help students acquire values. Teachers should know and recognize their own values, thought patterns and judgments while trying to help students acquire them through living values education programs (Bakioğlu & Tokmak, 2009; Karuppiah & Berthelsen, 2011; Eryong & Li, 2021). For this reason, the Living Values Education (Living Values Education, 2004) program, which is supported by UNESCO and is a global movement to create a culture of peace, was developed and twelve values were prioritized by considering two dimensions, personal and social. These values are Cooperation, Freedom, Happiness, Honesty, Humility, Love, Peace, Respect, Responsibility, Simplicity, Tolerance and Unity. These values, which students acquire both in the family and in their educational life, radically affect students' behaviors, perspectives, feelings and thoughts, and teach individuals how to behave in social life (Moore, 2010, p. 45).

Living Values Questionnaire Form (LVQF): This is a questionnaire consisting of twelve (12) values (Cooperation, Freedom, Happiness, Honesty, Humility, Love, Peace, Respect, Responsibility, Simplicity, Tolerance, and Unity) from the "Living Values Education Program" (Living Values Education, 2004). Teachers were asked to rate their level of possession of the values in this questionnaire on a scale of 1 to 5. The lowest possible score was twelve (12) and the highest was sixty (60). For the content validity of the questionnaire, the opinions of three different experts with a Ph.D. in the field were used. For the statements in the item pool in the form, the experts were asked

to mark the "appropriate", "not appropriate", and "your suggestions if not appropriate" sections next to each item. The items that the experts considered appropriate were included in the SDSF. The Living Values Questionnaire was created by making the necessary changes to the items that were requested to be changed. The Cronbach's alpha coefficient calculated for the reliability study of the Living Values Questionnaire was found to be .82.

Data Collection and Analysis

Statistics software (SPSS v.29) was used to analyse the data. Percentages (%), frequencies (f), arithmetic averages ($\overline{X}$), and standard deviations (S) were calculated over the total value scores obtained from the form, and statistical analyses according to the variables "*students' scores*, *gender, department, region of primary-secondary-secondary-high school education*", *unrelated group t-test* and *one-way analysis of variance (ANOVA)* and Tukey HSD test results were examined to determine the direction of the differences. These methods were chosen as they allow for detecting group differences in Likert-based perception scores and are widely used for interpreting survey data in educational research. Tukey's HSD was applied post-hoc to identify specific group differences. Although cluster or pattern analysis was considered, the sample size and nature of self-reported perception scores aligned more closely with descriptive statistics and ANOVA approaches.

Validity and Reliability

Since it is quantitative research, the validity was ensured according to expert opinions by complying with the "*Ethical Principles*" of Higher Educational Council of Türkiye. In the data collection process, "*data diversification*" was ensured by working with the "*volunteers*" and students from different levels and departments.

Results

This section provides statistical analyses of the data obtained from the study group. It examines the level of YTU, Faculty of Education students' possession of the values in the "*European Living Values Education Programme*". Table 1 below gives the lowest, highest and mean scores of YTU, Faculty of Education students regarding their possession of values in the "European Living Values Education Programme."

Table 1. Living Values Score Averages of YTU, Faculty of Education Students

N	Lowest Score	Highest Score	Arithmetic Mean ($\overline{X}$)	Ss
474	31	58	48.29	6.18

Table 1 shows the score values of the 474 undergraduate student participants who constitute the sample regarding their level of possession twelve (12) values (*Cooperation, Freedom, Happiness, Honesty, Humility, Love, Peace, Respect, Responsibility, Simplicity, Tolerance* and *Unity*) in the "European Living Values Education Programme". According to Table 1, the lowest score for the values was 31, and the highest score was 58. The mean score of the sample for all values was 48.29.

Table 2. The t-test results of the Faculty of Education Students' "*Living Values Possession Levels according to Gender, Primary, Secondary and High School Region Variables"*

Gender	**n**	$\overline{X}$	**S**	**sd**	**t**	**p**
Female(1)	283	48.82	5.86	472	2.24	.02*
Male(2)	191	47.51	6.56			
Primary School Region	**n**	**x**	**S**	**sd**	**t**	**p**
Rural(1)	154	48.57	5.167	471	0.688	.45
Urban(2)	319	48.15	6.623			
Secondary School Region	**n**	**x**	**S**	**sd**	**t**	**p**
Rural(1)	78	47.35	5.26	472	1.66	.09*
Urban(1)	396	48.48	6.33			
High School Region	**n**	**x**	**S**	**sd**	**t**	**p**
Rural(1)	68	47.45	4.73	472	1.50	.31
Urban(2)	406	48.44	6.38			

*p< .05

When Table 2 is examined, it is seen that the total scores of YTU, Faculty of Education students regarding the values in the "European Living Values Education Programme" show a significant difference according to "*Gender*", sd(472)=2.24, p< .05. In terms of gender variable, x=48.82 for female students, and x=47.51 for male students. In terms of gender variables, it is seen that female students have a higher score than male students. Regarding the values in the European Living Values Education Programme, it was observed that the value levels of YTU, Faculty of Education students did not differ significantly according to the region where they studied "*Primary School*", sd(471)=0.68, p< .05. In other words, it can be said that the average values of the YTU, Faculty of Education students are close to each other in terms of the variable of the region where they attended primary school. Regarding the values in the European Living Values Education Programme, it was seen that the value levels of YTU, Faculty of Education students did not differ significantly according to the region where they studied *"*Secondary School*"*, sd(472)=1.66, p< .05. In other words, it can be said that the mean value scores of YTU, Faculty of Education students are close to each other in terms of the region in which they study secondary school. Regarding the values included in the European Living Values Education Programme, it was seen that the value levels of YTU, Faculty of Education students did not show a significant difference according to the region where they studied "High School", sd(472)=1.50, p< .05. In other words, it can be said that the

value score averages of YTU, Faculty of Education students according to the region where they study high school are close to each other.

Table 3. ANOVA Test Results of the Faculty of Education Students' "*Level of Possession of Living Values" according to the Variable of Department*

Graduated Faculty	Sum of Scores	df	Mean Square	F	Sig.
Between Groups	1016.132	8	127.017	3.46	.001*
Within Groups	17059.328	665	36.687		
Total	18075.460	473			

*p< .05

When Table 3 is analysed, it was seen that there is a difference in the mean scores of YTU, Faculty of Education students' living values possession according to the department (F=3.46, p< .05). The results of the Tukey HSD test to determine the source of this difference are given in Table 4.

Table 4: TUKEY HSD Test Results of Faculty of Education Students' "*Level of Possession of Living Values" according to the variable of "Department"*

Department	**n**	$\overline{X}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
(1)Preschool Teaching	**53**	48.92	**-**	**.23**	**.72**	**.94**	**.98**	**.21**	**1.00**	**.27**	**.88**
(2)Primary Teaching	**52**	**49.88**	**-**	**-**	**.99**	**.007***	**.86**	**1.00**	**.28**	**1.00**	**.97**
(3)English Lang. Teaching	**53**	48.96	**-**	**-**	**-**	**.71**	**.99**	**.99**	**.78**	**.99**	**1.00**
(4)Soc. Sci. Teaching	**52**	45.46	**-**	**-**	**-**	**-**	**.38**	**.006***	**.92**	**.009***	**.16**
(5)Maths Teaching	**52**	48.11	**-**	**-**	**-**	**-**	**-**	**.84**	**.99**	**.89**	**1.00**
(6)Computer &ITT	**52**	**49.92**	**-**	**-**	**-**	**-**	**-**	**-**	**.26**	**1.00**	**.97**
(7)Science. Teaching	**52**	**49.75**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**.33**	**.92**
(8)Turkish Lang. Teaching	**54**	48.60	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**.98**
(9) Psychology C&G	**53**	48.29	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

A one-step multiple comparison procedure and statistical test, also known as the Tukey HSD (Honestly Significant Difference) test, is used to determine the source of the difference in ANOVA results. It can be used to accurately interpret the significance of the difference between means selected for comparison due to outliers. According to the Tukey HSD test, there is a statistically significant difference between the primary teaching department and the social sciences teaching department (p=0.007), between the social sciences teaching department and the computer & ITT department (p=0.006), and between the social sciences teaching department and the

Turkish language teaching department (p=0.009). This disparity indicates that social sciences education exhibits diminished levels of Life Values.

Although the age in which we live is a period of rapid changes, there is a need for values in organizing personal, social, and community life. There are vital principles that must be followed in every age while maintaining human relations with human beings or human relations within society (Sevinç, 2006, p, 232). The conflict between newly introduced values due to rapid change and old values, resulting in a crisis of values, has intensified. Furthermore, the situation has gotten more complex due to "globalization", which presents an ambiguous distinction between its "cultural" and "economic" dimensions. In this era, endorsing societal precepts through educational programs will promote more effective social functioning. Consequently, in this century marked by significant value conflicts, imparting values that will advance society to future generations through education is essential (Adıgüzel & Ergünay, 2012, p. 31). Globalization alters some values of persons and communities or prompts the adoption of new values in human and social life. This scenario is equally applicable to Turkish society. Since values are effective in the lives of individuals, they also provide information about individuals' beliefs, attitudes, and behaviours (Sevinç, 2006, p. 230).

Values, when examined within the framework of social culture, exhibit robust interconnections (Doğan & Sezer, 2009, p. 509). Values influence human attitudes, behaviours, and decisions, as well as govern responses to encountered events (Bakioğlu & Tokmak, 2009, p. 65; Halstead et al., 2000). During the socialization process, it is essential for individuals to assimilate national and universal values. Children acquire fundamental principles from their family and immediate surroundings. Subsequently, the educational process commences for the individual. The pupil, upon interacting with a teacher, develops essential knowledge, skills, habits, and values. Cipani (2008) asserts that the educational and training process is imbued with professional and personal values, which teachers unconsciously or consciously bring into the classroom. Consequently, to impart fundamental values to children within educational settings, educators must first recognize their own values (Cangelosi, 2000; Oktay, 2001, p. 97). Consequently, the values of educators become prominent in the educational process.

Upon examining the values designated as fundamental or pedagogical in this research, it becomes evident that love, respect, and tolerance are crucial in human relationships. The first of these, love, signifies intimacy, unity, and perpetual acceptance. Students arrive at schools and classrooms adequately equipped to maintain the interest and affection of their teachers. Students derive pleasure and satisfaction from the company of cherished friends. Affection is essential for the establishment and evolution of various types of relationships. It unites individuals and fosters cohesion and solidarity. Love is a fundamental virtue that imparts significance to human existence (Perese & Wolf, 2005, p, 593). The teacher's kind demeanour fosters the student's motivation to study (Erden, 2011, p, 150). The primary responsibility of the instructor is to instil a passion for learning. Teaching involves fostering emotional engagement and connection, both of which support students' motivation and learning (Hotaman, 2010, p, 1419). Respect is another value as significant as love. Respect is a principle encompassing acceptance and

comprehension. Respect is a mode of communication that transforms interpersonal negativities into positives (Perese & Wolf, 2005, p, 596). Self-respect allows individuals to better recognize their positive and bad traits, fosters self-acceptance, reduces defensiveness, and facilitates more acceptance of others. Individuals possessing this structure also exhibit respect for others. Irrespective of their religious, linguistic, racial, socioeconomic, gender, or educational position, individuals can engage with others via tolerance and acceptance. To facilitate successful and meaningful communication, it is crucial for individuals to respect both themselves and others (Yüksel Şahin, 2024, p, 33). As students remain in the "learning process", they are prone to making erroneous decisions and committing mistakes (Erden, 2011, p, 149). The teacher's tolerance in these circumstances facilitates pupils' acquisition of the truth (Hotaman, 2010, p, 1418). It is essential to recognize that allowing kids to make mistakes is the most effective approach to facilitate proper learning. Tolerance encompasses a composite of tolerance, acceptance, kindness, and compassion (Von Bergen & Collier, 2013). Tolerance is a crucial value that facilitates understanding, moderation, balance, patience, and the endurance of differences, including the acceptance of unconventional behaviours and thoughts (Willemse et al., 2005). Tolerance involves the acceptance of others while preserving the boundaries of one's personality (Belasheva & Petrova, 2016; Ryan & Bohlin, 2003; Kaztaevna et al., 2015). Tolerance constitutes an acceptance founded on the premise that individuals are prone to mistakes, rendering it unjust to pass judgments on them based on such missteps.

A civilization characterized by happy individuals exhibits elevated production, efficiency, and quality of life. Happy individuals are more inclined to exhibit honesty. Honesty is defined as the "truthfulness of conscience, absence of deceit, integrity, and a realistic consistency towards oneself and others". Similar to honesty, humility constitutes a comprehension and a mode of existence. An individual's possessions do not grant superiority or privilege over others. Humility enables an individual to sustain equilibrium among peers and exemplify modest conduct for others. Individuals with all these attributes also enhance the value of peace. Peace is the condition of being aware of internal and external stimuli and coexisting harmoniously with them, representing one of the fundamental ideals. This era requires individuals who are aware of their obligations. The concept of responsibility is defined as "the set of expectations that individuals assign to themselves while existing within a social framework" (Özdemir, 2007, p. 196). A fundamental value in life is sincerity. Simplicity is the condition of being genuine and truthful, transparent and comprehensible to oneself and others. Sincerity signifies trustworthiness. It so serves a crucial function in human interactions and is an essential value for effective communication. This value also conveys the essence of unity. Unity is an individual's readiness to coexist, engage, and collaborate with others. Unity significantly contributes to the safeguarding of essential values such as peace, justice, and equality on a broad spectrum. All these values are crucial for maintaining both individual and community harmony.

The study's results indicate that three of the twelve qualities in the "Living Values Education Program"—love, respect, and tolerance—are embraced by students at the faculty of education. It may be asserted that the values perceived by Turkish students

as paramount are fundamentally the most significant professional values for the teaching profession (Erden, 2011, p. 149; Hotaman, 2019, p. 101).

Limitations of the Study

The research possesses certain limitations. The primary limitation is that the study employed a cross-sectional design. Administering the scales to the same individuals throughout several time intervals and observing the temporal changes could produce more dependable results. A further disadvantage of the study is that the questionnaire employed is reliant on self-reporting. Social approval should be considered in self-reporting. A further weakness of the study is that it employed a quantitative research methodology. Future studies may yield more comprehensive information through qualitative or mixed-method research.

Discussion and Recommendations

In this research, the high scores of YTU, Faculty of Education students who will become teachers in the future regarding the mentioned living values according to their own perceptions show that family, school and social life fulfil their instructive function for individuals in terms of these and similar values. The average score from the data collection tool, from which it is possible to get a maximum of 60 points, was $\overline{X}$ =48.29. When this score value is converted over 100, it corresponds to 80.48%. In addition, it was observed that there were significant differences between the scores of female students and male students in favour of females and in favour of those studying in the city according to the region in which they attended secondary school.

Four (4) of the twelve values (12) in the European Living Values Education Programme are the same as the "Turkish Ministry of Education's (MoNE) Core Values" (*Honesty, Love, Respect, Responsibility*), "*Unity*" corresponds to the MoNE's "Patriotism" values, and the other values (*Cooperation, Freedom, Happiness, Humility, Sincerity, Tolerance* and *Unity*) are compatible with Turkish national values. It is essential that the value, which takes an important place in the establishment and development of the social structure, are possessed by the students of the faculty of education, who will be teachers and who are the operators of the education system in terms of bringing these values to the students. Values function as essential regulators in maintaining and developing social life healthily and appropriately. The fact that YTU, Faculty of Education students possess the values included in the European Living Values Programme, which is compatible with the core values of the Turkish Ministry of Education, is also essential for Türkiye, which strives to become a member of the European Union. In this study, it is seen that the average scores of the students are at a reasonable level. When the statistical analysis of the data obtained from the students was analysed based on students' gender, it was determined that female students reached higher mean scores than male students, that is, the difference is in favour of female students.

Every society supports family and educational institutions in ensuring its own survival. This support aims to ensure the production and training of the young

generation needed by society. While providing their continuity, societies preserve and enrich their cultural values through reproduction. Thus, as long as the society lives, values continue to exist as an essential part of this cultural heritage. Values are necessary for the healthy functioning of the social structure. Values, which regulate the lives of individuals (children, young people and adults) in society and are a set of criteria for the formation and development of interpersonal relations, are vital organizers that facilitate people to live together. Humans do not live alone, and they need common and accepted criteria to regulate their relations with others (human, animal, nature, etc.). These vital criteria are values themselves.

In conclusion, these results correspond with the observations of García et al. (2019), who noted a heightened value orientation among students in socially oriented fields. The observed gender difference aligns with trends identified in the studies conducted by Komalasari and Sapriya (2016), who ascribe these differences to early socialization processes. The absence of notable disparities among school locations may suggest the substantial impact of university socialization or a reasonably consistent value communication in pre-university education.

As a result, pupils imitate their parents at home and their teachers in the classroom. In this context, educators facilitate their students' acquisition of these values not only by teaching but also by living and exemplifying them in practice.

Since teachers serve as role models for their students, enhancing the qualitative dimension of teacher education is crucial to ensure that core values are not only taught but embodied. Rather than conveying values through direct instruction or advice alone, it is more effective for educators to demonstrate values through consistent behaviours, thereby facilitating social learning. Aligning professional ethics in teaching with core values and ensuring these are reflected in all classroom practices can significantly contribute to students' internalization of those values.

Moreover, values such as *justice, equality, honesty, objectivity,* and *non-discrimination*—which are integral to the teaching profession—should be intentionally and thoroughly introduced to every teacher candidate during their training. In order to strengthen the continuity of school-based value education, collaboration between schools and parents should be encouraged, reinforcing shared practices from both family and community life.

Beyond the school setting, non-governmental organizations (NGOs) can play a supportive role in value education by initiating projects and creating educational materials. Leveraging digital platforms and social media for this purpose can greatly enhance outreach and engagement, especially for young learners and prospective teachers. Additionally, university programs may include value self-assessment workshops as part of teacher orientation or pedagogy courses, helping students reflect on and articulate their own value systems. Similarly, educational technology courses can be enriched with digital storytelling and content creation tasks focused on the twelve core values, enabling future educators to internalize and effectively communicate these values in both classroom and online environments.

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Teaching Quality in Serbian Higher Education during Crises: A Qualitative Case Study of Professors and Students' Reflections[1]

By Jelena Maksimović[*]

This paper explores the perceptions of university professors and students on teaching quality in higher education during two overlapping crises in Serbia: the COVID-19 pandemic and the 2024–2025 student-led university blockades. A qualitative case study approach was employed, based on semi-structured interviews with 120 participants (90 students and 30 professors) from four major universities. Thematic analysis revealed that both crises disrupted traditional teaching practices while simultaneously accelerating digital transformation. Students reported challenges related to motivation, reduced interaction, unequal access to technology, and limitations in practical learning, whereas professors emphasized increased workload, difficulties in sustaining engagement, and the steep learning curve of digital platforms. Despite these difficulties, participants highlighted positive outcomes such as flexibility, recorded lectures, continuity of education, and the development of new digital competencies. Both groups identified hybrid teaching as the most sustainable long-term model. The findings underscore the role of socio-demographic factors, the need for professional development, and investments in digital infrastructure, while situating the Serbian case within the broader discourse on crisis-driven transformations in higher education. This research contributes context-specific insights and provides actionable recommendations for policymakers and institutions seeking to strengthen resilience in higher education.

Keywords: higher education, teaching quality, professors, students, qualitative case study, crisis, online learning, hybrid teaching, Serbia

Introduction

Higher education systems worldwide have faced multiple crises in recent years, most notably the COVID-19 pandemic, which forced universities to transition rapidly to online teaching (Pokhrel & Chhetri, 2021; Rashid & Yadav, 2020). In Serbia, the situation was further complicated by the 2024 Novi Sad Railway Station collapse, which not only caused significant societal disruption but also triggered large-scale student protests and blockades of faculties across the country. These blockades directly affected the organization of academic life and raised questions about the resilience of higher education institutions in times of crisis.

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The pandemic and subsequent blockades both illustrate how higher education must adapt to sudden and disruptive circumstances. Online learning provided opportunities for continuity and flexibility, but also revealed critical challenges such as reduced student engagement, unequal access to digital infrastructure, and difficulties in maintaining the quality of practical instruction (Bralić & Katić, 2020; Gupta & Sharma, 2020; Paudel, 2021). While these issues have been widely studied in international contexts, the Serbian case presents a unique dual crisis—health-related and socio-political—that demands further investigation.

In line with this aim, the study pursued the following objectives:

1. To explore the perceived advantages and disadvantages of online and hybrid teaching.
2. To identify the main challenges faced by both professors and students.
3. To examine the influence of socio-demographic characteristics on perceptions of teaching quality.
4. To propose recommendations for improving resilience and teaching quality in higher education.

By addressing these objectives, the study contributes to a better understanding of crisis-driven education in Serbia and offers insights relevant to higher education policy and practice in similar contexts.

Online Teaching during the COVID-19 Pandemic

The global COVID-19 pandemic reshaped higher education, forcing universities to rapidly transition to online teaching. Digital platforms enabled teachers to share multimedia content and create interactive environments that contributed to student satisfaction and skill development (Haider & Al-Salman, 2020). E-learning encouraged independent knowledge acquisition and critical thinking but also raised concerns regarding inequalities in access to technology and internet infrastructure (Jena, 2020). Research highlighted that while doctoral students benefited from flexibility and remote mentoring, undergraduates often struggled with self-regulation and motivation in the absence of structured deadlines.

Studies across different countries provide valuable insights into this transformation. In Russia, teachers viewed the shift to online learning as an intellectual challenge that redefined their role as facilitators (Almazova et al., 2020). In Libya, online learning was perceived as a positive contribution to teaching quality (Maatuk et al., 2022), while in India, inequalities in digital access proved to be a major barrier (Jena, 2020). Paudel (2021) emphasized that with proper preparation and training, teachers could achieve successful online delivery, while Stojanović (2020) documented the negative psychosocial effects of remote education in Serbia, including student anxiety, reduced motivation, and the absence of live interpersonal interaction.

The emergency transition to online learning exposed weaknesses in teacher preparedness. Short preparation time, lack of resources, and limited training led to

significant professional stress. Nevertheless, positive aspects such as new teaching tools, innovative knowledge assessment methods, and flexibility were widely acknowledged (Maatuk et al., 2022). From the students' perspective, emotional wellbeing was a recurring issue: many reported fear, helplessness, and anxiety (Pavlović et al., 2021). Similar findings were observed in China, where decreased social contact caused heightened levels of stress and anxiety.

Research suggests that students' preferences vary. While some preferred face-to-face interaction for better collaboration, others reported improved concentration in online environments (Karalis & Raikou, 2020). These findings indicate that no single teaching modality is universally superior; rather, adaptability to individual student needs is crucial. Online teaching requires greater responsibility for time management and self-directed learning (Paudel, 2021), while hybrid models appear to balance flexibility with the benefits of live engagement (Sousa & Mangas, 2024).

The role of digital infrastructure remains central. In Africa, many universities were unable to complete academic years due to unstable internet access (Dampson et al., 2020). Similar challenges were reported in Serbia, where students from smaller settlements had significantly fewer opportunities to participate in online classes compared to peers from urban centers (Stojanović, 2020). These findings underscore the widening gap in educational opportunities based on socioeconomic status and geography.

In Serbia, the COVID-19 pandemic was followed by a new disruption in the form of student-led blockades of faculties (2024–2025). While international literature on online education during emergencies is extensive, limited research has explored the intersection of pandemic-induced digital transformation with political and institutional crises. This study therefore positions Serbia as a unique case for examining how universities and students adapt to multiple overlapping crises, highlighting both the challenges and the resilience of higher education.

Methodology

The study investigates how university professors and students in Serbia perceived the quality of higher-education teaching during two overlapping crises—the COVID-19 pandemic and the 2024–2025 faculty blockades. Guided by this aim, the study pursued five objectives: (1) examine perceived advantages and disadvantages of online/hybrid teaching; (2) identify technological, pedagogical, and emotional barriers; (3) explore positive practices that may persist beyond crises; (4) assess the influence of socio-demographic factors (e.g., year of study, faculty type, place of residence, participation in blockades); and (5) formulate recommendations to strengthen resilience and teaching quality. Corresponding research questions asked: how professors and students perceive teaching quality during crises; what the principal barriers and opportunities are; how socio-demographics shape experiences; and what actions can improve resilience in Serbian higher education.

A qualitative case study was employed to enable in-depth exploration within a bounded system—Serbian higher education under dual crisis conditions. This approach follows established guidance for context-specific inquiry into social phenomena (Yin, 2018; Stake, 1995).

The sample comprised 120 participants: 90 students and 30 professors from four public universities (Belgrade, Novi Sad, Niš, Kragujevac). Student variation (year of study, study program, urban/rural residence) was purposively sought due to its potential impact on access to digital tools and perceptions of online teaching. Professors represented social sciences, humanities, medical, and technical fields.

A purposive–random approach was used. Students were recruited via university mailing lists, faculty forums and professors were contacted through academic networks. The sample does not claim statistical representativeness but secures diversity of perspectives. No distinction was enforced between students involved in blockades and those not involved, as the focus was on perceptions of teaching quality, not political participation.

Semi-structured interviews were conducted online via Zoom and Google Meet between mid-May and early June 2025. In total, 120 participants (90 students and 30 professors) from four public universities in Serbia took part. Each interview lasted approximately 40–60 minutes. The interview guide, aligned with the research aim and questions, included open-ended prompts focusing on: experiences with online and hybrid classes during the crises; perceptions of teaching quality and student engagement; challenges related to technology, communication, and motivation; strategies used to maintain learning continuity; and recommendations for improving higher education resilience in crisis conditions.

Interviews were transcribed verbatim and analyzed via thematic analysis (Braun & Clarke, 2006) supported by NVivo. The procedure included:

1. initial coding of segments related to teaching quality, challenges, opportunities;
2. aggregation of codes into broader themes aligned with research questions (e.g., *Motivation and Learning Habits*, *Technological Barriers*, *Institutional Preparedness*);
3. comparison across student and professor groups to identify convergences/ divergences;
4. interpretation in light of the literature to enhance analytic rigor.

Credibility and dependability were addressed through member checking (theme summaries shared with a subset of participants) and thick description of context (pandemic and blockades) to support transferability. All participants provided informed consent; anonymity and confidentiality were ensured.

Research Results

The analysis of the interviews revealed several key themes that reflect how students and professors experienced the shift to online teaching during the blockades.

Divergent Learning Strategies and Motivation

Students' responses showed wide variation in learning approaches during the lockdowns. While some students engaged in self-study and prepared for postponed

assessments, others reported a lack of motivation due to the absence of clear deadlines and exam schedules. As one student noted:

> "I can't force myself until I have a specific date, until I have some pressure…"

This indicates that external structures, such as deadlines and scheduled assessments, played a crucial role in sustaining students' engagement. Similar findings in the literature emphasize the importance of self-regulation and time management in online learning environments (Paudel, 2021).

Institutional Responses to the Blockades

Faculties responded differently to the crisis. For example, the Faculty of Philosophy in Novi Sad fully transitioned to online teaching, while other faculties implemented hybrid solutions. These institutional decisions shaped student experiences and reveal the uneven preparedness of higher education institutions to handle sudden disruptions. This variability highlights the lack of a unified national strategy for ensuring learning continuity.

Use of Digital Tools

Students and professors reported frequent use of a wide range of digital platforms. These tools served different functions, from learning management systems (Moodle, Google Classroom) to collaboration tools (Google Workspace, Microsoft 365) and evaluation platforms (Turnitin, GradeScope). However, while the variety of tools demonstrates flexibility, several students mentioned challenges in navigating multiple platforms simultaneously. This suggests that digital fragmentation may undermine teaching quality, as consistency in platform use is essential for reducing cognitive load.

Perceived Benefits and Challenges

Participants recognized some positive aspects of online learning, including flexibility, access to resources, and continuity of education during blockades. However, they also emphasized key challenges: limited interaction with professors, reduced opportunities for peer collaboration, and inequality in access to stable internet and devices. These findings align with previous research showing that online teaching can exacerbate existing inequalities among students (Jena, 2020).

Need for Flexible Models

Across interviews, both professors and students emphasized the need for flexible and hybrid teaching models to safeguard the continuity of higher education in crisis situations. This indicates that while online learning was largely perceived as a temporary solution, many stakeholders saw potential in maintaining some aspects (e.g., digital resources, recorded lectures) beyond the crisis period.

The analysis revealed both similarities and differences between students' and professors' reflections on teaching quality during crises, as we can see in Table 1. and Table 2.

Both groups highlighted the importance of online and hybrid teaching for ensuring educational continuity. Students and professors alike recognized the advantages of flexibility and digital access to resources, but also pointed out the limitations of reduced interaction and communication.

Students emphasized the impact of uncertainty on motivation and learning outcomes, while professors focused on increased workload and stress caused by the rapid transition to online platforms. While students struggled with deadlines and maintaining self-regulation, professors expressed concern about sustaining engagement and ensuring quality feedback.

Table 1. Students' Perspectives on Thematic Categories, Illustrative Quotes, and Interpretations

Theme	Illustrative Quote	Interpretation
Divergent Learning Strategies and Motivation	"I can't force myself until I have a specific date, until I have some pressure…" (Student)	Students' motivation strongly depends on external structures (deadlines, scheduled exams). Lack of clear assessment timelines reduces engagement and self-regulation.
Institutional Responses to the Blockades	"At the Faculty of Philosophy in Novi Sad, classes were transferred online during the blockade."	Faculties responded unevenly to the crisis. This highlights differences in institutional preparedness and the absence of a coordinated national strategy.
Use of Digital Tools	"We used Zoom for classes, Google Docs for group work, and Moodle for tests."	The multiplicity of platforms shows flexibility but also creates digital fragmentation, increasing cognitive load for students.
Perceived Benefits	"It was easier for me to attend lectures from home and re-watch recorded classes."	Online teaching provided flexibility and resource accessibility, supporting continuity of education despite blockades.
Challenges and Inequalities	"I couldn't follow all classes because of poor internet at home."	Online teaching amplified existing inequalities, particularly in technology access and stable connectivity.
Need for Flexible Models	"Hybrid teaching would be the best solution so we don't lose the year."	Both students and professors see hybrid models as sustainable, balancing flexibility with the need for live interaction and practical training.

Students often experienced inequalities in access to stable internet and digital devices, while professors reported difficulties in mastering new tools in a short timeframe. This asymmetry suggests that institutional support needs to address both student access and professor training.

Positive Outcomes: Despite challenges, both groups identified lasting benefits of digitalization. Students valued recorded lectures and flexible access to learning materials, while professors planned to continue using digital tools to enhance their teaching practices.

Table 2. Professors' Perspectives on teaching Quality during Crises

Theme	Illustrative Quote	Interpretation
Adaptation to Digital Tools	"We had to learn to use Moodle and Zoom in just a few days."	Professors experienced a steep learning curve, reflecting the need for professional development in digital pedagogy.
Increased Workload	"Preparation for online classes takes much longer than traditional lectures."	Online teaching significantly increased professors' workload, particularly in preparing digital materials and managing platforms.
Reduced Student Engagement	"It is harder to maintain interaction and see if students follow the lecture."	Professors struggled with reduced feedback and limited student participation in virtual settings.
Emotional Burden	"We felt pressure from both the institution and students during the blockades."	Professors experienced stress balancing institutional demands and student expectations.
Positive Outcomes	"Some tools actually improved my teaching and I will keep using them."	Despite challenges, professors identified lasting benefits, such as recorded lectures and digital resources.

Together, these findings suggest that students and professors experienced crises in complementary but different ways: students were primarily affected by motivation and access issues, while professors were challenged by workload and digital adaptation. Addressing both sets of challenges through comprehensive support systems can strengthen teaching quality and resilience in higher education.

Discussion

This study was guided by five research questions, and the discussion of results can be framed accordingly:

Q1: How do professors and students perceive the advantages and disadvantages of online and hybrid teaching?

Findings confirmed that both groups saw flexibility, continuity of education, and access to digital resources as advantages. However, students emphasized motivational problems and lack of interaction, while professors stressed workload and digital adaptation. This duality illustrates complementary but different perspectives on teaching quality.

Q2: What are the main technological, pedagogical, and emotional barriers to teaching quality during crises?

Results identified unstable internet, unequal access to devices, and fragmented digital platforms as key technological barriers. Pedagogically, reduced interaction and difficulties in assessing learning outcomes were central. Emotionally, students reported anxiety and lack of motivation, while professors described stress and pressure.

Q3: Which positive practices and innovations emerged that could persist beyond crises?

Both groups highlighted the value of recorded lectures, digital resources, and hybrid teaching models. Professors indicated plans to integrate some tools into regular practice, while students valued flexibility and reusability of materials.

Q4: How do socio-demographic characteristics shape perceptions of teaching quality?

Students from rural areas and lower socio-economic backgrounds experienced greater challenges with connectivity and access to devices. Year of study also influenced perspectives: senior students showed stronger self-regulation, while younger ones relied more on external structures such as deadlines.

Q5: What recommendations can strengthen resilience and teaching quality in higher education?

The findings suggest investments in digital infrastructure, professional development for professors, institutional strategies for hybrid learning, and targeted support for vulnerable student groups. These recommendations align with global calls for more resilient higher education systems in crisis contexts.

Conclusion

The findings of this study confirm several patterns reported in previous research, while also contributing new insights specific to the Serbian higher education context during crises.

First, both students and professors recognized the continuity and flexibility offered by online teaching. This aligns with international studies emphasizing the benefits of digital platforms in maintaining the academic process during the COVID-19 pandemic (Haider & Al-Salman, 2020; Almazova et al., 2020). However, the Serbian case reveals additional challenges caused by political blockades, where hybrid teaching was introduced not only as a pedagogical innovation but as a political necessity to prevent the loss of the academic year. This highlights a contextual dimension rarely discussed in global literature.

Second, the results underline the importance of motivation and self-regulation among students. Consistent with Paudel (2021), many students struggled with decreased engagement due to the absence of deadlines and structure. Professors, on the other hand, reported difficulties in sustaining interaction and providing feedback, echoing concerns about reduced student engagement documented elsewhere (Jena, 2020). The comparison of perspectives suggests that online education challenges both sides of the learning process, requiring institutional mechanisms to support motivation, communication, and accountability.

Third, technological barriers emerged as a major source of inequality. Students from rural areas and lower socio-economic backgrounds faced difficulties with internet connectivity and device availability. While similar issues were reported internationally (Bralić & Katić, 2020; Dampson et al., 2020), this study provides evidence that such inequalities were further compounded by political instability and institutional inconsistency in Serbia. This points to the need for more targeted policies addressing digital equity.

Fourth, professors emphasized the increased workload and stress associated with digital adaptation. While other studies have also highlighted the steep learning curve in adopting new technologies (Maatuk et al., 2021), the Serbian case indicates that this burden was intensified by external pressures—such as protests, institutional blockades, and uncertainties about accreditation.

Finally, both groups identified lasting positive outcomes, such as recorded lectures, access to digital resources, and the potential of hybrid teaching. These findings suggest that the crisis accelerated the digital transformation of higher education and created opportunities for innovation. However, as noted in previous research (Sousa & Mangas, 2024), these opportunities will only be sustainable if universities invest in infrastructure, training, and long-term digital strategies.

In sum, the discussion demonstrates that while Serbian higher education faced challenges similar to those seen globally, its unique combination of pandemic and political blockades created a dual crisis with complex implications. The study contributes by showing how overlapping crises shape perceptions of teaching quality and by emphasizing the need for resilience strategies that combine pedagogical, technological, and institutional dimensions.

Highlights of this research are: The study explores teaching quality in Serbian higher education during two overlapping crises: the COVID-19 pandemic and the 2024–2025 student-led blockades of universities.

Qualitative case study based on 120 semi-structured interviews with professors and students across four universities.

Findings reveal key challenges: decreased student motivation, unequal digital access, increased workload for professors, and reduced interaction.

Both groups identified benefits such as flexibility, recorded lectures, and new digital skills, pointing to hybrid teaching as the most sustainable solution.

The study contributes to understanding crisis-driven transformations in higher education and provides practical recommendations for policymakers and universities in supporting resilience.

The study is limited by its sample size and focus on a single national context, which may affect generalizability. Future research should include comparative

analyses across countries and apply mixed-method designs to deepen understanding of teaching quality in crisis settings.

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Aquiring Knowledge via Higher Education in order to meet the Labor Market's Needs

*By Anica Hunjet**

Globalization processes bring significant changes to all segments of contemporary society and individuals, including higher education. The significant role of the higher education system lies in creating scientific professionals capable of advancing research activities through the rational integration and coordination of human knowledge, ultimately leading to discoveries that improve the quality of life and support economic development. Through the higher education system, individuals acquire high-quality educational and intellectual capital, which serves as a foundation for generating numerous ideas and innovations. The quality of an education system is defined by its ability to generate knowledge, skills, competencies, and experiences that enhance living standards and contribute to establishing sustainable growth and development for society as a whole. Gaining quality knowledge equates to building competitiveness, which is achieved through ongoing investment in personal learning and education, empowering individuals to excel, improve their efficiency, and ultimately strengthen their position in the labor market. The Republic of Croatia must orient itself toward the future and adapt to labor market needs to ensure that the higher education system remains competitive and capable of addressing the challenges of modern and fast-paced globalization. This study will be based on an analysis of data from the Croatian Bureau of Statistics related to investments in research and development within higher education institutions and scientific organizations. The research findings will ultimately serve as a basis for policymakers in Croatian higher education to undertake corrective actions and formulate future development strategies.

Keywords: knowledge, higher education, competencies, labor market

Introduction

In this modern age of globalization and the regional unification of the European space, higher education should be connected to the economy and utilized to foster overall growth, contribute to employment, and improve its financial aspects. The digital transformation and the application of new technologies in both the economy and the education sector are creating new opportunities to promote open science and strengthen scientific excellence, as well as connect academic, research, and business domains through investments in innovation research and development (SRASUU, 2021-2027).

It is important to determine the fundamental factors of the Croatian economy, the labour market, and higher education, which are crucial for successful transition from the higher education system to the labour market for highly qualified individuals looking for their first jobs (Tecilazić, 2023). The role of the higher education system is to develop scientific personnel who will advance science

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through the harmonization of knowledge and apply it to support economic growth. By creating a knowledge-based society, information and knowledge are integrated not only into the reforms of the higher education system but also into the society as a whole (Samawi & Samawi, 2025).

Learning outcomes represent one of the top priorities of the Bologna process, as they serve to ensure maintenance of high-quality levels within the higher education system. The Croatian Qualification Framework plays a very important role in higher education reforms, as it defines the individual competencies that facilitate employability and support personal development, which is necessary to build social connections. A quality education system produces knowledge, skills, and competencies that contribute to improving living standards, sustainable growth, and the development of society as a whole. To gain knowledge means to become competitive. Investments in knowledge and education make people more successful, and, thus, more competitive in the labour market. According to the Higher Education and Scientific Activity Act (HESAA, Official Gazette 151/2022), higher education institutions encompass universities, colleges, art academies, and polytechnics. Furthermore, a higher education institution is founded with the objective of carrying out higher educational, scientific, artistic, and professional activities.

In accordance with the aforementioned The Law on Higher Education and Scientific Activity (ZVOZD, Official Gazette 119/2022) , university studies prepare and train students to work in science, art, higher education, business, the public sector, and society in general, as well as to develop and achieve scientific, artistic, and professional accomplishments. Higher education institutions can also organize and conduct professional development courses for the purposes of lifelong learning, which provide competencies in accordance with the occupational standard or the competency set, and the qualification standard or set of learning outcomes from the Croatian Qualification Framework Registry. A professional development course is not considered a study programme; however it can be financed via a voucher with the purpose of accessing the labour market.

In the academic year 2021/2022, Republic of Croatia had 9 active public universities, thirteen public polytechnics, three private universities, five private polytechnics, and thirteen private higher education institutions, with a total of 154 894 students (DZS, 2021). Acquiring and improving knowledge also generates certain costs, which is why financing the system is particularly important.

Although enrolment in higher education is substantial, completion rates remain comparatively low. In 2018, the tertiary education attainment rate in Croatia reached 34.1%, significantly below the European Union (EU) average of 40.7%.

Furthermore, the employment rate of recent graduates in Croatia is relatively modest. In 2021, it stood at 80.9%, whereas the EU average for the same period was 84.9%.

Despite these challenges, Croatia demonstrates strong performance in fields crucial for contemporary economic development. The proportion of graduates in STEM disciplines has been both high and increasing, amounting to 28.5% in 2020, compared with the EU average of 24.9%. Similarly, the share of graduates in information and communication technologies (ICT) exceeds the EU average, reaching 4.7% in Croatia compared with 3.9% at the EU level (European Commission, 2022).

Organization of the Higher Education System

Paired with the effects of globalization, the modern environment has turned terms such as economic and social development into increasingly important discussion topics within international organizations active in development, national developmental policies, and research and development (Baban, 2025). Educational literature and politics regard education as the most feasible developmental investment, particularly within knowledge societies and knowledge-based economies (Pastuović, 2012). A knowledge-based society is one that invests significantly in knowledge and whose population has a high educational attainment. It is important to note that a knowledge-based society not only possesses the knowledge but also applies it effectively. The educational objectives of such a society focuses on permanent employability and the capacity to strengthen social inclusion (Pastuović, 2012).

The Republic of Croatia is one of the countries that signed the Bologna Declaration and began its application back in 2005. Following the adoption of the Bologna Process, over 900 study programmes (Mozvag, 2022) conducted by higher education institutions in Croatia were evaluated and reorganized in accordance with the Bologna principles (Španiček, 2005). Significant progress was achieved in some areas, particularly visible in the organization of the three main levels of higher education (undergraduate, graduate, and postgraduate studies), but also in the flexibility of study progamme choice, the access to the labour market, and the academic mobility of students. Notable progress was also achieved in the area of quality assurance and promotion, as well as the integration into the European higher education system (Osmanović Zajić & Maksimović, 2023). One of the main priorities within the framework of the Bologna process reforms is the emphasis on learning outcomes, which are an integral part of quality assurance in the higher education system. The fundamental purpose of the Bologna reform was to place students at the center of the educational process (AZVO, BP, 2022). The starting point was maximal alignment of offered educational programmes with the identified capabilities and preferences of students, alongside the strategic interests of the state and, based on them, the needs of the labour market.

In second place are teachers/researchers whose capabilities determine the actual realization of learning outcomes and the quality of research. The priority of the reform is to create incentive-based institutional and financial frameworks that support high-quality teachers and researchers in accordance with comparable international criteria. The quality of the teaching process should be grounded in the development of key competencies, with particular emphasis on collaborative and self-directed learning, responsibility, independence, entrepreneurship, reflective and critical thinking, student creativity, and a multidisciplinary approach to the planning, organization, and implementation of instruction.

The integration of modern digital technologies into the educational process can substantially enhance the quality and efficiency of learning and teaching in higher education. By using appropriate digital tools, services, and online platforms, instructors should be able to communicate effectively and disseminate educational and professional materials to students and colleagues in accordance

with ethical standards. Moreover, educators are expected to understand digital security risks and threats, as well as the broader implications of the production and use of digital technologies for health, energy consumption, and the environment.

In addition, educators should possess well-developed communication and interpersonal skills, demonstrating proficiency in both oral and written communication and the ability to present complex content clearly. Such competencies enable students to apply acquired knowledge, skills, and attitudes in academic discourse and within the wider scholarly community (MZO, 2018).

Universities open to international competitions should be placed at the forefront. This also includes the transformation of universities into research-centered institutions, as well as stronger connections and alignment with the needs of the Croatian economy and society (Družić, 2020; Jandrić, 2025).

In addition to the Higher Education and Scientific Activity Act, the Act on Quality Assurance in Science and Higher Education and the Act on the Croatian Qualifications Framework (Official Gazette 22/13, 41/16, 64/18, 47/20, 20/21) also apply. The Act on Quality Assurance in Science and Higher Education determines quality assurance and promotion in science and higher education through mechanisms such as initial accreditation, reaccreditation, themed evaluation, and periodic external independent evaluation of the internal quality assurance system. The Act also prescribes the organization and the activities of the Agency for Science and Higher Education (The Act on Quality Assurance).

The need to evaluate higher education institutions arose from the necessity to improve the quality of higher education, in order to encourage these institutions to become more responsive to competitive external market demands (Baketa, 2019).

The development of the Croatian Qualification Framework started in 2006, while the Act on the Croatian Qualification Framework was adopted in 2013. The evaluation of higher education institutions also began during this period. State graduation exams and the computerized method of applying to higher education institutions were first introduced in 2009 (AZVO, HE 2022). The Strategy for Education, Science and Technology was adopted by the Croatian Parliament in 2014.

In addition to becoming more competitive, individuals create significantly greater opportunities on the labour market for themselves by investing in their own education. In order to acquire the necessary knowledge, it is vital to engage high-quality, well-educated teaching personnel capable of transferring appropriate knowledge. Achieving this requires the continuous professional development of teachers to ensure the quality of the teaching process. Consequently, it is crucial to significantly increase investment in higher education in order to enable and ensure a high-quality and competitive education. The quality of human capital is determined by the quality of the education system and investments made in it (Babić, 2004). Education provides easier access to information, promotes better health management, and encourages active participation, enabling individuals to take better care of their health and engage more actively in social life, thereby supporting sustainable economic growth (Bejaković, 2004). Quality human capital is capable of innovating and creating new technological products and processes, as well as quickly adopting new knowledge vital to the implementation of new technologies, thus generating economic growth. The aforementioned reform of

higher education and the implementation of the Bologna process resulted in a significant increase in the number of polytechnics in the Republic of Croatia. This is likely due to the fact that polytechnics are flexible higher education institutions that adapt to the needs of the market by offering a wide range of study programmes. One of the objectives of the higher education reform is to strengthen professional studies and align polytechnics with regional needs and specificities. The key characteristic and advantage of polytechnics lies in the ability to provide students with not only a certain level of knowledge but also the skills necessary for professional work, thus preparing them for direct integration into the work process (MZO, HE 2022).

Polytechnics are primarily market-oriented rather than dependent on the state budget, and are characterized by greater efforts toward securing special extrabudgetary income. Therefore, most polytechnics generate their revenue from the market. By encouraging such market orientation and the collaboration with the economy, it is possible to support the future development of polytechnics with relatively small budget allocations (Kozina, 2012).

It can be said that polytechnics promote diversity within the higher education system, as they represent institutions oriented toward market needs. Polytechnics ensure quality, regularly modernize existing and new study programmes, and achieve high employment rates for their graduates. These are the exact reasons why the binary model was implemented. The binary model has proven successful in other European countries, as it improved both societal and economic competitiveness by increasing the competitiveness of the employers who hired professional studies graduates (Krivačić, 2010).

Higher education trains professionals who will be capable of solving professional and practical problems in the future, thereby contributing to the growth of society's wealth in economic, cultural, and intellectual terms (Savičević, 2009).

On March 22, 2023, the Croatian Government adopted the Decision on the Adoption of the National Education System Development Plan for the Period Until 2027, as well as the Action Plan for the Implementation of the National Education System Development Plan for the Period Until 2027. One of the main objectives of the National plan is to ensure higher employment rates for persons with qualifications acquired through vocational education and training, which should encourage more people to continue their education and acquire the necessary knowledge and skills. A special objective of the plan is to increase completion rates in higher education (Official Gazette 33/2023).

Investments in Higher Education

The availability of higher education is a right of every individual; therefore, one of the main goals of the Bologna process is to ensure social justice within all higher education systems in Europe, including the Republic of Croatia. The objective is to ensure that a person who wants to study and acquire quality competencies is never denied education due to their social status (ENQA, 2015).

However, there are, regrettably, some obstacles that prevent certain social groups from accessing higher education, such as family income.

This is precisely why higher education institutions should dedicate a portion of their activities toward promoting innovations, thus improving the labour market and generating a significant new source of funding. It is important that higher education institutions recognize the value of participating in various EU-funded projects that offer diverse opportunities. Investments in one's own higher education may be observed as an individual decision made with the expectation of returns on the time and money invested. Increased public investment in education is not sufficient to increase the number of people pursuing education; therefore, it is equally important to pay attention to returns on private investment in education, and the potential for career advancement that higher education enables. In this modern age of globalization, permanent employment is only attainable through continuous education and professional advancement throughout one's working life (Babić, 2004).

It is vital to research the labour market and define the specific occupations, knowledge and skills that Croatia needs in order to achieve rapid development – not only in the economic sector, but in all areas of society. Higher education institutions should then define their enrollment and funding policy in accordance with the gathered indicators and research data. In this way, the Croatian higher education system would direct all its strengths and resources towards promoting higher education.

It is important that individuals recognize the importance of investing in their own education. Some advantages of education are improved competitiveness in the labour market, better employability, and the acquisition of competitive and high-quality skills and knowledge that make individuals internationally competitive. The aforementioned higher education reform has already resulted in positive developments in funding– the funds allocated to higher education have increased by 50%, which was accompanied by a simultaneous increase in the number of teachers and students. Based on the number of new students, it is easy to conclude that many individuals have recognized the importance of investing in their education to attain knowledge and expand their opportunities in the labour market (AZVO, PA 2022).

It is frequently posited that investment in higher education contributes to increased labor productivity. In most developed countries, however, the proportion of public funding allocated to higher education is lower than that devoted to primary and secondary education. Nonetheless, on average, higher education institutions continue to rely predominantly on public financing, a pattern particularly evident among OECD member states. Private expenditure on higher education varies considerably across countries and is largely influenced by the level of tuition fees set by universities. Notably, countries that host many of the world's leading universities—such as the United States and the United Kingdom—exhibit the highest shares of private investment in higher education (Goksu & Goksu, 2015).

Public support is provided through various mechanisms, including subsidies, direct institutional funding determined by student enrolment numbers, and co-financing of student accommodation. In countries such as the United Kingdom,

Australia, and New Zealand, these forms of public assistance constitute approximately 20–30% of the total revenue of private higher education institutions.

Higher Education Development Strategy

Universities, including polytechnics, play a key role in the creation of a knowledge-based society. The ultimate goal of their activity is the establishment of a society comprised mostly of highly educated people. Accordingly, higher education institutions must create mechanisms that support the creation and application of knowledge, skills, and cognition. The application of knowledge is nothing but a high-quality, productive, and efficient use of information. Therefore, the state must recognize the importance of additional investment in education, research, and development. All relevant actors within the state and economic system must be fully engaged in building a knowledge-based society. To remain competitive with other European Union countries, it is vital to continually improve the entire education system, and increase the investments allocated to this field. Compared to other EU members, Croatia regrettably invests significantly fewer resources into its education. The Republic of Croatia and its citizens must begin to recognize the importance of intellectual capital and investments aimed at improving it.

At this point, it is necessary to create an innovation society based on knowledge, learning, and the use of modern technologies. It is also very important to prevent the knowledge from becoming obsolete by constant improvement and modernization, so it can always respond to the challenges of the market. Some countries have even succeeded in combating poverty thanks to their investments in knowledge, which serves as a great illustration of the real power of knowledge. Numerous inventions have resulted from investment in education across all levels, as well as the parallel advancement of technology that has supported these endeavors. According to Article 66 of the Constitution of the Republic of Croatia (URH, Official Gazette 85/2010), education is available to everyone under equal conditions. The strategic goals of higher education in the Republic of Croatia in the area of student standards are also based on the aforementioned Article, as outlined in the Strategy for Education, Science and Technology (MZO, 2014) and within the framework of improving the social dimension of higher education, as mentioned in the National Plan for Improving the Social Dimension of Higher Education in the Republic of Croatia for the period between 2019 and 2021, adopted by the Government of the Republic of Croatia (Tecilazić, 2023).

The development and transfer of new skills and competencies to future generations, along with their practical application, should contribute to the creation of a knowledge-based society that drives economic growth and success. Individuals who are willing to learn and develop their intellectual capital are those capable of developing in a way dictated by modern society and the market. Therefore, it is in the best interest of a modern economy to increase investments in education, as this will increase the number of highly educated individuals who can become its core competitive advantage. The importance of knowledge is becoming increasingly apparent not only in the high-tech fields but also in areas requiring

applied expertise. It has become crucial for attaining a quality position in the labour market. Knowledge has effectively taken over the role of the traditional workforce in the labour market. It is important to recognize the significance of knowledge dissemination, given that accelerated globalization and industrial production have created a demand for concrete, specific knowledge across all sectors of society. Investments in education, research, professional advancement, and immaterial goods are vital for the future efficiency and prosperity of the economy.

Furthermore, the higher education system also determines the society and economy through its influence on the cultural environment and economic development, given that every country reaps significant benefits from research and development in higher education. It is important for a higher education system to prioritize the following: it must keep track of the changes occurring in the labour market to satisfy both long- and short-term society needs, but it also has to track the progress of both teachers and students in the process of knowledge transfer and management.

The competition in all areas of business is becoming increasingly steep; therefore, all available potential and resources (such as knowledge) should be utilized accordingly. In order to turn knowledge into a source of competitive advantage, it is important to recognize the value of investing in one's education and knowledge. Average no longer suffices – nowadays, one must aspire to business excellence in order to succeed, which is only possible through investment in knowledge. A country's international competitiveness depends on the quality of its human capital, which, in turn, depends on the education level, health, and capabilities of its population (Pastuović, 2012).

The Labour Market

The labour market represents the supply and demand of workers and encompasses various elements, including worker preparation, employment, professional advancement, termination, periods of unemployment, job search competition, as well as the competition in the workplace (Božiković, 2021). Employers in the labour market act as buyers, but also as suppliers, particularly in relation to offered salaries and working conditions. Workers, on the other hand, act as sellers, given that they offer their skills, knowledge, and experiences to employers (Serena, 2017).

The economy in Croatia is characterized by high unemployment rates and slow dynamics of creating new workplaces, which is a direct result of several factors, including a non-flexible labour market (Božiković, 2021).

Development and technological advancement demand a highly educated workforce, which is why highly educated individuals generally integrate more easily into the labour market. There is, however, a growing level of unemployment even within this segment of the workforce, which suggests there is a certain degree of mismatch between the higher education system and the dynamic needs of the labour market (HGK, 2015). In order to facilitate the labour market's capacity to absorb new workers, it is necessary to implement reforms in the education system by adapting to the employers' needs, and by improving its adaptability in response

to changes in the labour market, particularly in the domain of anticipating the most in-demand professions of the future (HGK, 2015).

The most sought-after workers are those with a broad set of knowledge and skills, including both general and specialized expertise, who speak foreign languages and have mastered the information and communication technologies, which means they are actively adapting to the needs of the labour market (Božiković, 2021). Globalization is a process of strengthening interconnections among people across the planet by eliminating restrictions to the movement of people, ideas, cultures, and by fostering the creation of a large, global market. The educational profiles businesses require in their employees should be reflected in their business strategies and development plans for the next five to ten years (Družić, 2020).

Acquiring Competencies for the Labour Market

Apart from knowledge, it is also important that individuals acquire certain competencies consisting of a combination of knowledge, skills, attitudes, and values during their education. Competencies enable individuals to generate and upgrade their knowledge in the labour market, thus opening doors to other markets. These competencies are basically competitive skills that differentiate an individual from other candidates on the labour market.

To ensure the knowledge transferred during the higher education process via lectures is really adopted and later on applied in the real world, it is necessary to integrate certain innovations into the monotonous process of teaching, and to implement certain activities during lectures that encourage active student participation and help maintain motivation. This type of lecture enables students to understand new concepts better and apply them in the workplace later on. The knowledge transfer also plays a crucial role in high-quality classes during higher education; therefore, it is important to keep track of it. This can be achieved through a grading system or direct feedback from the students (Kovač, 2022).

Based on the knowledge acquired during higher education, individuals gain certain capabilities such as mastering complexity, inferring, and reasoning, but they also develop learning skills necessary for continuous lifelong learning.

Furthermore, it is extremely important to strengthen the teaching staff to ensure they understand students' needs (including those of their families), as well as their social, cultural, and economic environment. Teaching and transferring knowledge constitute a demanding profession, whereby the education and professional development of the teaching staff play a crucial role in conducting successful classes.

Polytechnics should create optimal conditions for the creation and transfer of specific knowledge, so that later their students can transform that knowledge into business success. Polytechnics usually encourage the development of problem-solving abilities and competencies necessary for knowledge promotion.

One of the main problems in the modern higher education system is the disparity between individuals who have access to knowledge and those who do not. This creates a large gap due to an increase in the quantity of knowledge

among those who have access to higher education. It is necessary to reduce this gap in order to fully focus on knowledge exchange and management.

The creation and dissemination of knowledge naturally incur certain costs, which is why it is very necessary to secure appropriate funding for the education system. Apart from the fact that the demand for knowledge should match the market supply, students who have received financial support should be responsible and complete their educational obligations on time, thus fostering a fair balance between individuals funded by the state and those who have received no state funding. In addition to state funding, there are also private investments and funds, given that the public funding cannot meet all the needs and requirements of the growing number of participants in the education system. The funds allocated to higher education institutions as public expenditures are still not sufficient; however, they are increasingly being recognized as a top priority for further development. Moreover, higher education is slowly shifting its orientation toward the private sector as one of its main sources of funding. In most countries, higher education consists of a network of public and private institutions, such as higher education schools and polytechnics. It is necessary to recognize the importance of funding higher education in order to ensure its further development, increase its efficiency, and maintain appropriate quality standards. Public financial support may have a positive impact on the balance within the higher education system. It must be noted that individuals with higher education generally enjoy better employment prospects on the Croatian labour market (Babić, Matković, & Šošić, 2006).

By investing in higher education, one fosters the acquisition of necessary competencies, high-quality knowledge, skills, experiences, and capabilities, which in turn assure an advantage on the labour market in terms of employability. In this age of globalization, permanent employment is only attainable via continuous education and lifelong professional improvement. It is very important to research the labour market and define the professions Croatia needs in order to achieve accelerated economic growth in both the economic and social sectors. Higher education institutions should define their enrollment policies based on these indicators. The aforementioned higher education reform has resulted in some positive developments regarding funding – the funds allocated to financing higher education have increased by 50%, which was accompanied by a simultaneous rise in the number of teachers and students. Investments in knowledge are among the most viable investments, given the fact that knowledge-based economies tend to be most successful (Kozina, 2012).

The Croatian Qualification Framework

The Croatian Qualification Framework (Official Gazette 22/13, 41/16, 64/18, 47/20, 20/21) is also an important part of the higher education reform. It provides a foundation for a precise definition of an individual's competencies throughout the entire education system, thus ensuring greater employability, personal development, and better social integration. Such a unified system makes it possible to measure and compare learning outcomes, which results in understanding the labour

market's needs, conducting additional educational programmes, and evaluating all learning outcomes. The Croatian Qualification Framework sets clear and high-quality criteria for competencies acquired during higher education; furthermore, it also sets clear expectations regarding the qualifications individuals will have attained after completion of a particular study or educational programme.

The Croatian Qualification Framework is based on the Croatian educational tradition, while it also takes into consideration the present state of the Croatian education system, as well as the developmental needs of the economy, individuals, and society as a whole. At the same time, it aligns with the principles of the European Qualification Framework, European guidelines, and international regulations.

The basic objective of all the changes implemented within the higher education system is to achieve a high-quality education system connected to the labour market, as well as to build a successful economy supported by strong social connections.

It is important that individuals recognize the importance of investing in their own education, i.e., they need to understand all the advantages that the higher education system offers, such as increased competitiveness in the labour market, better employability, and the acquisition of relevant knowledge that makes them internationally competitive. Based on the growing number of students, it is possible to conclude that numerous individuals have recognized the importance of investing in their own education with the objective of gaining knowledge and expanding their opportunities on the labour market.

In terms of improving the quality of studies, it is vital to invest in infrastructure and, most notably, computerization. Computerization may be singled out as one of the most important factors for enhancing both quality and efficiency. Furthermore, future reforms should focus on promoting innovations and diversity, thus improving the market. Apart from developing new technologies to keep up with the constant and quick globalization processes and labour market changes, it is crucial to continuously modernize the system in order to increase employability and simultaneously develop the overall economy. One of the top priorities within the framework of the Bologna process is the implementation of learning outcomes, which form an integral part of the higher education quality assurance system.

Knowledge and the Concept of Knowledge Management

Knowledge is expensive; however, without knowledge, there is no life or work quality. It is an economic resource; hence, it is crucial to invest in knowledge to achieve competitiveness and quality (Gregory, 2025). The appropriate application and practical implementation of knowledge are equally important in the later stages of knowledge management. Knowledge ensures that we possess various high-quality, relevant information about the environment we live in, which is crucial for our survival in both business and private spheres. Knowledge is the process of gathering large amounts of information, followed by processing that information in order to further exchange and manage it. Knowledge is created

from the information available to an individual, and is subsequently transferred and eventually managed.

The development and evaluation of acquired knowledge, skills, and competencies play a crucial role in personal development, competitiveness, social cohesion, and employment (Gregory, 2025). Such development should provide international mobility for both potential employees and students, as well as respond to the demands of the global labour market. Knowledge holds a key position within the globalized and turbulent business world, as it is the only resource that ensures a successful position in the complex labour market. The total human potential is usually characterized by a set of knowledge, skills, competencies, capabilities, and creativity of an individual. The continuous acquisition and use of knowledge lead to the creation of new ideas, which, supported by modern information and communication technologies, significantly facilitate overcoming various problems faced by individuals and organizations. It is vital to increase investments in quality education, as knowledge offers a general sense of security to individuals, and simultaneously improves the quality of their lives. The acquisition of new knowledge can stimulate creativity and the development of additional skills. Knowledge, skills, and capabilities may become obsolete; therefore, individuals must continuously learn and gather new skills throughout their lifetime. It is essential to establish a quality education system in all educational institutions, so that the final product – an individual's knowledge- reflects its quality and applicability on the labor market. The role of knowledge as a competitive advantage is essential for development and survival in an increasingly demanding market, and it represents a key factor in economic growth (Kozina, 2012).

Investments in knowledge are the most feasible and profitable investments, as the most developed economies are knowledge-based. The entire educational system exerts a strong and positive influence on global economic growth and development because, on today's scale, the so-called education industry is competitive and capable of creating specific knowledge, skills, and competencies that contribute to increasing the quality of life. The development of informatization and accelerated scientific and technological progress is grounded in the fact that today's modern economy relies on knowledge, and that in such an economy, the key role is played by individuals who can create and generate informational knowledge, i.e., knowledge based on scientific research.

Knowledge management is reflected in an increase in the value and importance of knowledge. If knowledge is continuously collected, upgraded, and utilized, it will eventually create an environment that fosters the sharing and transfer of knowledge, thereby generating valuable intellectual capital. Globalization has accelerated trends in the fields of commerce and technological development, as well as in the development of the education system. The education system should definitely be strengthened even further so that it can respond to the challenges of the contemporary market. In today's economy, knowledge and innovations serve as the driving forces behind the market and the development of the entire economy.

Optimized knowledge management is usually reflected in significant market competitiveness. The modern market is subject to numerous daily changes. The world is developing faster than ever before, particularly in the areas of computerization and infrastructure, as well as in the advancement and management

of individual knowledge with the objective of achieving better social and market standing. The market does notn't measure only the quality of the offered products – it also measures the quality of individual and societal knowledge.

In today's conditions of accelerated globalization and numerous innovations, both organizations and individuals have to become competitive and recognizable on the market based on their knowledge. There are people who possess appropriate knowledge on the market, which is why it is so important to stand out in the crowd and become recognizable based on individual knowledge (Tecilazić, 2023).

After transitioning from industrial to contemporary computerized economy, material goods no longer count as the main resources. They have been replaced by knowledge, so it can be concluded that the value of an economy lies within its knowledge. Economic growth and development, as well as innovations, are based on intellectual capital. Therefore, it is in the contemporary economy's best interest to increase investments into knowledge in order to increase the number of highly educated employees that will soon turn into its most prized competitive advantage.

Knowledge can be a source of competitive advantage as well as a source of producing innovation. This enables a quicker dissemination of new ideas within the society and the overall economy. In the future, people will likely become more oriented toward production, exchange, and management of knowledge. The demand for knowledge should grow in accordance with the demands of the contemporary globalization processes. Social development is also accompanied by the creation and implementation of various innovations. As knowledge and technology develop, so does the advancement of knowledge, thus broadening the educational supply on the market. The supply is becoming increasingly diverse, which is vital when it comes to satisfying the needs of the market.

In order to ensure high-quality development of the education system, it is necessary to keep track of several elements:

- Continuous research of the labour market in order to enable the education system's continuous adaptation to market development and globalization trends
- Continuous improvement and creation of new education programmes that are flexible and adaptable in accordance with the changes within the higher education system.

Investments into education, professional advancement, and other are vital for the future efficiency and prosperity of an economy. It is important to understand and recognize that knowledge represents the ability to create new business solutions, to combine knowledge across various business arenas, and to accelerate the process of creating new products and services in order to outperform the competition (Babić, 2004).

Methodology and Research

For the purposes of this paper, secondary data serve as the principal source of information. The most frequently consulted materials include scholarly articles, as

well as data published on the official websites of the Ministry of Science and Education, the Agency for Science and Higher Education, the Central Bureau of Statistics, and the European Commission. The methodological approach combines several research methods, including descriptive, deductive, classificatory, analytical, and generalization methods. The descriptive method is applied to clarify the key concepts related to higher education and the labor market, while the deductive method is employed in examining the contemporary challenges and trends characterizing the labor market of the Republic of Croatia.

The aim of this paper is to investigate the relationship between the higher education system and the labor market by analyzing the effectiveness of the transition of highly educated individuals into employment.

Research Questions

1. There is a statistically significant relationship between higher education and the employment rate in the Republic of Croatia.
2. Digitalization has a negative impact on unemployment among employees without appropriate digital skills.

Hypotheses

Hypothesis H1: Higher investment in higher education and research and development (R&D) has a positive impact on the employability of highly educated people in the labor market.
Hypothesis H2: The alignment of study programs with the Croatian Qualifications Framework (CRO) and clearly defined learning outcomes increases the level of student competences and reduces the gap between the offer of higher education and the needs of the labor market.
Hypothesis H3: The level of innovation and digital competences acquired during studies is positively associated with the faster integration of young highly educated people into the labor market.

According to data collected by the Croatian Bureau of Statistics and the Population Census of 2001 (DSZ, 2001), the dynamics of the educational structure of the Croatian population aged 15 and older, by level of education, was as follows:

In 1961, only 1.2% of the population completed some form of higher education. In 1971, 2.2% of the population completed higher education, and by 1981, that percentage grew to 3.6%. Another ten years later, in 1991, 5.3% of the population completed some form of higher education, whereas in 2001, that percentage increased to 7.8%. The biggest problem in higher education was system inefficiency, no completion deadlines, and a large number of students who never finished their studies (Babić, 2004).

In addition to investments in education, many countries are increasingly allocating resources to science, research, and development, recognizing that the outcomes of scientific inquiry contribute to technological progress, advances in medical treatment, and more efficient resource management. Knowledge can be

considered a public good, as it is broadly accessible and its use generates positive externalities. In recent years, the promotion of science and research has intensified, reflecting the growing dependence of modern economies on knowledge-based growth and technological innovation.

The financing of scientific activity is commonly assessed through expenditure on research and development (R&D). With R&D expenditure amounting to 0.86% of GDP, Croatia ranks among the EU member states with the lowest levels of investment in this domain. By contrast, Slovenia and the Czech Republic approximate the EU average, each investing around 2.1% of GDP. The highest R&D expenditures are recorded in Sweden, Austria, Denmark, Germany, and Finland (European Commission, 2017).

The principal sources of R&D funding include the private sector, the public sector, higher education institutions, and private non-profit organizations. In most EU countries, including Croatia, the private sector constitutes a major contributor to R&D investment. In Croatia, the private sector accounts for 42% of total R&D expenditure, followed by contributions from the public sector and higher education institutions, while funding provided by non-profit organizations remains negligible (European Commission, 2017).

Education expenditure in the European Union ranges from 3% of GDP in Romania to 7% of GDP in Sweden. The Republic of Croatia, with a share of 4.5%, is close to the EU average.

There are 1781 study programmes in the Republic of Croatia, of which 727 are in STEM fields (38.9%) (Register of the Ministry of Education and Science, 2019) The share of persons who have completed their studies in STEM fields is 27, and the EU average is 25.8% (Eurostat, UOE 2017) (OECD, 2020). The Government of the Republic of Croatia has been awarding scholarships for STEM studies every year since 2017/2018.

This research was conducted based on international methodology – the Croatian Bureau of Statistics' Frascati Handbook from 2002. Gross domestic expenditures for research and development represent the total expenditures allocated to research and development during the observed year. For example, in 2011, these expenditures comprised current and investment expenditures in gross amounts (DZS, 2012).

Gross Domestic Expenditures for Research and Development by Scientific Field

Table 1. Gross Domestic Expenditures for Research and Development according to Science Branch in 2011

Scientific Field	**Amount (thousands HRK)**	**Share (%)**
Natural Sciences	600.000	24
Technical Sciences	880.000	35
Biomedicine and Health	350.000	14
Biotechnical Sciences	280.000	11
Social Sciences	270.000	10
Humanistic Sciences	150.000	6
Artistic Field	880	0.0001

Source: The Croatian Bureau of Statistics

Table 1 shows the data for the year 2011. In 2011, most funds were allocated to technical sciences (35%), followed by natural sciences (24%), biomedicine and healthcare (14%), biotechnical sciences (11%), social sciences (10%), and humanities (6%), with some insignificant funds allocated to the arts (0.0001%).

Gross domestic expenditures for research and development in 2016 include research and development conducted within the country but financed from abroad, as well as research and development conducted abroad. Internal research and development expenditures comprised all current and capital expenditures expressed in gross amounts and allocated to research and development conducted within the reporting unit, regardless of the funding source (DZS, 2017).

Table 2. Gross Domestic Expenditures for Research and Development according to Science Branch in 2016

Scientific Field	**Amount (thousands HRK)**	**Share (%)**
Natural Sciences	490.000	17
Technical Sciences	820.000	28
Biomedicine and Health	770.000	26
Biotechnical Sciences	440.000	15
Social Sciences	270.000	9
Humanities	150.000	4
Artistic Field	1.672	0.00572
Interdisciplinary Fields	20.000	

Source: The Croatian Bureau of Statistics

Table 2 shows the data for the year 2016. In 2016, most funds were allocated to technical sciences (28%), followed by biomedicine and healthcare (26%), natural sciences (17%), biotechnical sciences (15%), social sciences (9%), and humanities (4%), with some insignificant funds allocated to the arts and the interdisciplinary field of arts and sciences.

Gross domestic expenditures by science field for 2021 could not be displayed because the 2021 population census used a different data presentation methodology.

Research and development funding sources

Table 3. Research and development funding sources for year 2011

Source of Funds	**Percentage**	**Amount**
Own funds	33.60%	850.000
State and local government	46.40%	1.200.000
Private and public companies	8.10%	200.000
Nonprofit institutions	0.20%	5.000
Foreign clients	11.70%	300.000

Source: The Croatian Bureau of Statistics

Table 3 illustrates funding sources for research and development in 2011. It is evident that 46.4% of funds were allocated by the state and local administration, followed by 33.6% from own funds, 11.7% from foreign clients, and 8.1% from private and public companies. Only 0.2% of funds were sourced from non-profit organizations (DZS, 2012).

Table 4. Research and development funding sources for year 2016

Source of Funds	Percentage	Amount (HRK)
Own funds	0.442	1.300.000
State and local government	0.401	1.180.000
Companies	0.03	88.000
Higher education	0.017	50.000
Private nonprofit institutions	0.001	3.000
Abroad	0.109	320.000

Source: The Croatian Bureau of Statistics

Table 4 illustrates funding sources for research and development in 2016. In 2016, 44.2% of research and development was funded from own funds, followed by 40.1% allocated by the state and local administration. Furthermore, 10.9% of research and development was funded by foreign clients, whereas 3% of funds came from companies. 1.7% of funds were allocated by higher education institutions, whereas 0.1% of funds came from non-profit organizations (DZS, 2016).

Doctoral Dissertations defended in 2004, 2011, 2016, and 2021

Furthermore, the paper also wanted to present data on the defense of doctoral dissertations in 2004, 2011, 2016 and 2021 by individual fields of expertise.

In 2004, the majority of defended dissertations were from the field of biomedicine and healthcare (26.3%), followed by technical sciences (25.5%), natural sciences (17.4%), humanities (13.7%), and social sciences (10.4%). The fewest doctorates were recorded in the field of biotechnical sciences (6.7%) (Report on Doctorates, 2004, CBS).

In 2011, the majority of defended doctoral dissertations were from the field of biomedicine and healthcare (25%), followed by social sciences (22.2%), natural sciences (18.9%), humanities (13.7%), technical sciences (10.1%), biotechnical sciences (8.6%), and the interdisciplinary scientific field (1.2%). The fewest doctorates were recorded in the field of arts (0.3%) (Report on Doctorates, 2011, CBS).

In 2016, the majority of defended doctoral dissertations were from the field of biomedicine and healthcare (27.6%), followed by social sciences (19.8%), technical sciences (17.6%), humanities (12.5%), natural sciences (11.5%) biotechnical sciences (7.1%), and the interdisciplinary scientific field (3.0%). The fewest doctorates were recorded in the field of arts (0.9%) (Report on Doctorates, 2016, CBS).

In 2021, the majority of defended doctoral dissertations were from the field of biomedicine and healthcare (29.6%), followed by social sciences (19.9%), technical sciences (19.0%), natural sciences (12.5%), humanities (10.6%), biotechnical sciences

(5.0%), and the interdisciplinary scientific field (2.7%). The fewest doctorates were once again recorded in the field of arts (0.7%) (Report on Doctorates, 2021, CBS).

Discussion

Higher education has been regulated by the Act on Higher Education and Scientific Activity, and is thereby divided into university and professional studies. The Croatian Ministry of Science, Education and Youth, the Agency for Science and Higher Education, as well as numerous higher education institutions in the Republic of Croatia, have all invested significant efforts into maintaining the quality of higher education. Nowadays, the development of higher education is synonymous with the development of the overall society and the economy. The theory of human capital posits that investments in education are reflected in individuals' voluntary decisions to invest in their own education to reap future benefits. Highly educated individuals hold a more favorable position in the labour market; however, there remains a certain discrepancy between the needs of the labour market and the higher education system. The gap between employer demands and the supply produced by the higher education system makes the post-graduation transition into the labour market somewhat challenging. This has been confirmed by previous research, whereby 33% of responders stated they could not find a job due to insufficient competencies (Dedukić, 2021).

Furthermore, highly educated young people state they were not well informed about the labour market, which is further confirmed by data from 2021. In the aforementioned study, 67% of respondents confirmed they received insufficient information, noting that they expected to receive such information during classes or from employers.

An analysis conducted by the Agency for Science and Higher Education revealed that 46.2% of respondents were not required to complete mandatory professional practice during their study programme.

When it comes to higher education, it is still necessary to invest in quality improvements, as it is the key factor in the development of human capital and economic growth. The development of competencies increases productivity and competitive advantage.

Investment in education is a key factor in the development of society and the economy. The quality of education can only be improved through infrastructure development and the adaptation of study programmes to the needs of the labour market.

The data analysis conducted by the Croatian Bureau of Statistics shows a significant increase in the number of individuals who completed some form of higher education between 1961 and 2001. Over the observed period, the percentage rose from 1.2% to 7.8%, which further confirms the efficiency of the higher education system.

An analysis of gross domestic expenditures allocated to research and development by scientific field from 2011 to 2016 shows that most funds were allocated to technical sciences. A notable increase in the amount of funds allocated to biomedicine and healthcare was recorded in 2016, whereas only an insignificant amount of funds was allocated to the arts throughout the observed years. In 2011, the

majority of research and development was funded by the state and local administration, whereas in 2016, most funding came from own funds. Only an insignificant amount of funds was sourced from non-profit organizations throughout the years.

Additional insights can be drawn by comparing the number of defended doctoral dissertations in the years 2004, 2011, 2016, and 2021. The majority of dissertations were in the fields of biomedicine and healthcare, whereas the fewest were in the field of the arts. Furthermore, the number of dissertations from the field of social sciences recorded an increase from 10.4% to 22.2%, whereas the number of dissertations from the field of technical sciences decreased from 25.5% to 10.1%. However, the number of dissertations in technical sciences rose again in 2016, reaching 17.6%, and increased further in 2021 to 19.0%. The dissertations from the interdisciplinary field of science first appeared in 2011. A mild increase in the number of the aforementioned dissertations was first recorded in 2016 (3.0%); however, by 2021, this number dropped back down to 2.7%.

Research (Ahec Šonje et al. 2018) found that Croatia spends almost the most on higher education, but the investment is not efficient.

Debates concerning the level of educational expenditure increasingly draw upon empirical research, and numerous studies have demonstrated that funding for education in Croatia—across primary, secondary, and tertiary levels—remains inefficient. Assessments of efficiency typically involve comparing education-related expenditures with indicators of educational quality and learning outcomes, which are most often reflected in the labor market opportunities available to individuals with higher education qualifications.

Within the domain of higher education, institutions seek to maintain various forms of accreditation in order to align study programs and learning conditions with established standards, although resistance to such adjustments can still be observed within segments of the academic community. The linkage between higher education institutions and labor market needs remains insufficiently developed. Strengthening communication and cooperation with the business sector would likely contribute to improved labor market outcomes for graduates.

Public financing of higher education in Croatia covers salaries, current and capital expenditures, as well as elements of the student standard, including subsidized meals and accommodation. All remaining costs—such as portions of tuition fees, textbooks, and other educational materials—are borne by students or their families.

In line with the above considerations, the research findings confirm Hypothesis H1, which states that greater investment in higher education and in research and development (R&D) has a positive effect on the employability of highly educated individuals in the labour market.

Furthermore, Hypothesis H2 is also confirmed: the alignment of study programmes with the Croatian Qualifications Framework (CQF) and the formulation of clearly defined learning outcomes increase students' competence levels and reduce the gap between the supply of higher education and labour market needs.

Finally, Hypothesis H3 is confirmed as well: the level of innovation-related and digital competences acquired during studies is positively associated with the faster integration of young highly educated individuals into the labour market.

The interdisciplinary field of science and the arts was established by the Regulation on Scientific and Artistic Fields and Branches (Official Gazette 118/09, 82/12, 32/13, and 34/16). When establishing the aforementioned interdisciplinary field, the regulation-makers took into account the continuous development of science, as well as the polycentric nature of the scientific and higher education systems. As a result, the field was created that enables interdisciplinary cooperation among scientists and scientific organizations, facilitating a broad range of interconnected scientific projects.

By investing in their own education, individuals gain a competitive advantage in the labour market. Investments in education actively contribute to employability, thus reducing unemployment in the Republic of Croatia.

Conclusion

Higher education has been regulated by the Act on Higher Education and Scientific Activity, and is thereby divided into university and professional studies. The government started paying more attention to the quality of higher education after the recent higher education expansion. The Agency for Science and Higher Education, alongside the Ministry of Science, Education, and Youth, and numerous higher education institutions, has played a key role in this process and represents one of the fundamental institutions in the field of higher education. For years, the labour market has been characterized by high unemployment rates and a very slow rate of new job creation. This has resulted from several factors, such as an inflexible labour market and insufficient alignment with the educational system. Employment programmes should aim to incentivize the creation of new businesses, attract foreign investments, and provide education and training for experts at all levels.

The research results confirmed all three hypotheses formulated within the methodological framework of the study:

> Hypothesis H1: Greater investment in higher education and in research and development (R&D) positively influences the employability of highly educated individuals in the labour market.
> Hypothesis H2: The alignment of study programmes with the Croatian Qualifications Framework (CQF) and the presence of clearly defined learning outcomes enhance students' competence levels and reduce the gap between the supply of higher education and labour market needs.
> Hypothesis H3: The level of innovation-related and digital competences acquired during studies is positively associated with the faster integration of young highly educated individuals into the labour market.

Based on the available data and reports, Croatia's expenditure on education positions it near the average of developed countries, including OECD and EU member states. However, meaningful progress in labor market outcomes and national economic competitiveness will depend on the implementation of high-quality reforms within the education system—particularly reforms that align educational programs with labor

market needs, anticipate future occupational trends, and enhance the responsiveness of institutions to societal and economic demands.

A highly skilled and well-educated workforce is better equipped to adopt emerging technologies, assimilate new processes, and apply contemporary knowledge, all of which are essential in the modern era. Such human capital contributes directly to a country's economic performance and serves as a catalyst for sustained economic growth.

To achieve these objectives, stronger integration among the academic, research, business, and civil sectors is required. Improved collaboration would facilitate the creation and application of knowledge, enhance support for research and development activities, and enable Croatia to move toward global standards of excellence.

During the conducted secondary research, certain limitations were identified. A recommendation for future studies would be to carry out primary research using a survey questionnaire on a larger sample within the Republic of Croatia and across European Union member states, in order to obtain more robust and relevant findings.

Numerous countries have recognized the importance of investing in higher education and have, therefore, made it one of their top priorities. However, the global crisis has also affected the higher education system, leading to recent reductions in funding. Even though the educational system is generally resistant to radical changes, under such circumstances, it has begun making efforts to identify alternative sources of funding.

The objective of this paper is to demonstrate the importance of investing in higher education. The purpose of such investment lies in the fact that all developed economies are based on a knowledge system; hence, the education system should become the top priority of the state's economic policy. Furthermore, the accelerated development of the higher education system might significantly contribute to reducing unemployment. The quality of the education system is an important determinant of both economic growth and social development.

Investments in education and science have been increasing each year, in line with the economic situation in the Republic of Croatia; however, this growth remains insufficient. In conclusion, the need to adapt the education system and connect it to the economic sector has been recognized. In order for the country to have a brighter future, it is necessary to increase investment in the higher education system, both through new forms of financing and through student support policies funded by additional public and private funds.

The modern world is undergoing rapid changes in all its segments. These changes have placed significant pressure on the educational system, as it represents the most efficient instrument for economic and societal adaptation to both current and anticipated circumstances. The need for broader access to education is increasingly emphasized nowadays – education should be accessible, high in quality, and diverse in scope. Study programmes should enable students to become educators themselves, instead of remaining passive recipients of knowledge. Through the adaptation and innovation of study programmes, as well as the development of integrated technologies in the field of education, modern education has become more closely aligned with the real employment needs and opportunities. This has also contributed to the development of new models of knowledge and creativity.

These research results may serve as a basis for Croatian higher education policymakers to take corrective action and create future development strategies.

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Strategically Managing Enabling Resources in Higher Education Institutions to Realistically Support their Core Functions and Activities

By Serwan M J Baban[*]

Higher Education Institutions need to operate purposefully and effectively to remain viable in the current competitive environment. Strategic planning can help achieve this mission and meet expected objectives through direct and continuous teaching, research, and consultancy services, as well as effective engagement with society, government, and the private sector at all levels. However, higher education institutions, partly due to poor management of available human, financial, and physical resources and mis-targeting these enabling resources, often face significant challenges in attaining these aspirations. This paper presents a strategic approach for managing enabling resources in Higher Education Institutions by developing and implementing plans to effectively direct available human, financial, and physical resources towards sustaining the core functions of learning and teaching, conducting research, and providing consultancy and community service. Hence, the paper provides a framework and a management instrument for determining how to maximise the use of available enabling resources to robustly support institutional core functions and related activities in the continuously changing and competitive environment of higher education.

Keywords: Enabling Resources, Strategies, Management, Relevance, Higher Education

Introduction

Higher Education Institutions must remain relevant and competitive while effectively engaging with society, government, and the private sector (Baban &Rafik, 2024). However, achieving these goals is challenging for several reasons. These include fluctuations in student enrolments, technological impacts including AI, globalisation, market influences driven by competitive threats, and the pressure to meet public expectations alongside obligations to become more transparent and accountable in the new competitive landscape (Keller, 1983; Baban, 2017; Moja, 2007; Bengtsen & Gildersleeve, 2022; Marshall et.al., 2024). These conditions have compelled HEIs to find ways to manage these demands and pressures, determine their future direction, and simultaneously succeed in an evolving competitive environment (Baban, 2018a, 2024a; Hudson, 2023; Elfert &Ydesen, 2024; Schildermans &Tröhler, 2024). A way forward for universities is to innovate for the future and to build the required competencies to advance lifelong learning, both degrees and micro-credentials, intellectual and job-ready skills, using online or hybrid delivery models. Also, to develop and progress the required novelty to manage

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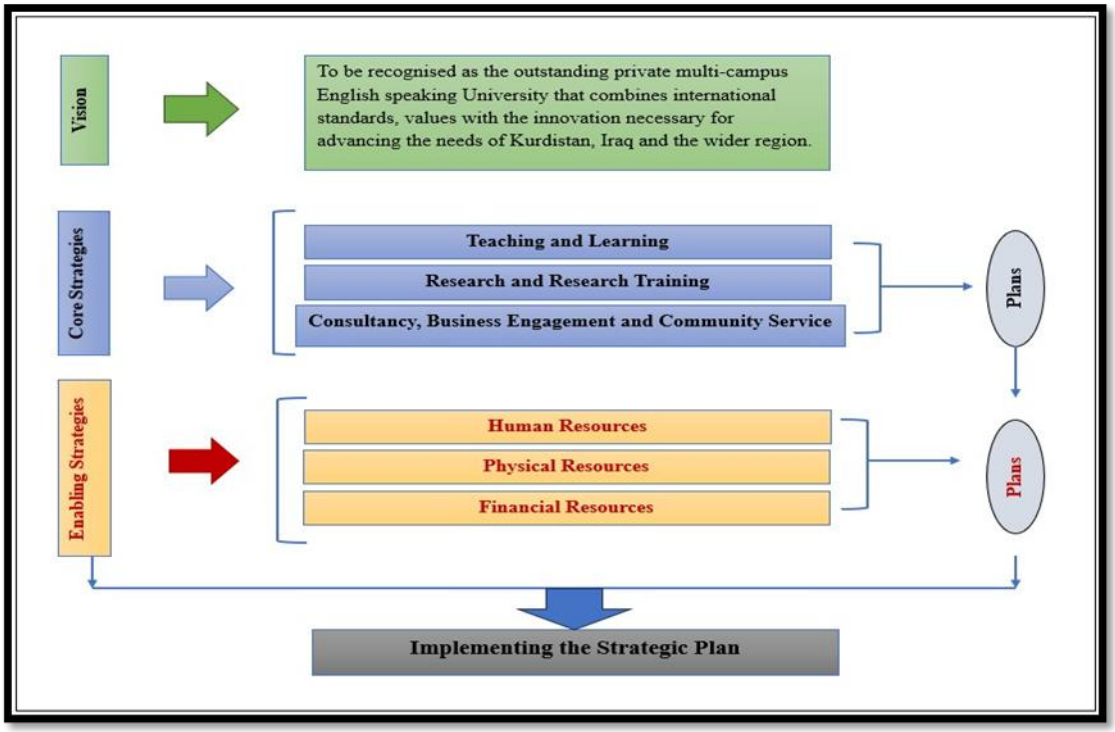
the ongoing global challenges like climate and sustainability, and to employ technology at speed. It has been acknowledged that resource management in Higher Education Institutions (HEIs) plays a pivotal role in determining institutional effectiveness, quality assurance, and long-term sustainability. The deployment of human, financial, and physical resources represents the foundation upon which universities fulfil their teaching, research, and community engagement mandates (OECD, 2020). Therefore, the success of the essential transformations in HEIs will, to a large degree, depend on adopting, developing, and implementing strategic planning in general and for enabling resources in particular as the proactive and flexible means for operating competitively in a fluctuating environment (Keller, 1983; Baban, 2017, 2018b; Baban & Rafik, 2024).

Crisp (1991) defines strategic planning in higher education as the set of activities designed to identify the appropriate future direction of an institution, including the steps to move in that direction. Therefore, strategic planning is viewed as a pathway for formulating institutional mission, vision, values, drivers, developing organisational focus, and prioritising the use of all available enabling resources (Hinton, 2012). HEI strategies tend to have a vision, plans for core functions, as well as plans for enabling resources. The planning process is also tasked with ensuring that these individual components are aligned with each other and mutually supportive (Baban, 2024) (Figure 1).

Strategic planning in the current competitive environment can guide Higher Education Institutions to evaluate their strengths, weaknesses, opportunities, and threats, indicating how to remain viable by continuously enhancing their standing in teaching, research, and consultancy while effectively engaging with society, government, and the private sector at all levels (Chaffee, 1984; Gumport & Sporn, 1999; Hinton, 2012; Baban, 2018a, 2018b). However, partly due to the mishandling and mistargeting of enabling resources, they often face significant challenges in achieving these aspirations (Baban, 2017, 2018b).

Evidently, in recent times, most HEIs tend to face challenges in effectively managing enabling resources (human, financial, physical, technological, and informational), resulting in diminished institutional performance and limited student outcomes. However, despite recognition of their importance, a major limitation of the literature across all enabling resource domains is their fragmented treatment. Most studies focus on individual resource types in isolation rather than their interdependence and without analysing the synergy between them (Ngare, 2023; CEDTECH, 2024). Only a small subset of scholars employed integrative frameworks such as the RBV or Dynamic Capabilities Theory, which emphasise how institutions mobilise and reconfigure resources to adapt to change (Teece, 2018). Empirical work by Salmi (2020) and Sunder (2022) suggests that HEIs achieve sustainable performance when human, financial and physical resources are strategically aligned. In this context, this work aims to define, identify gaps in, and propose a practical approach for the efficient management of enabling resources in higher education institutions.

Figure 1. The Basic Structure for a HEI Strategic Plan (Baban, 2024)



In terms of research questions, the work aims to examine how effective the current management practices of enabling resources are. Also, what challenges do higher education administrators and staff face in managing enabling resources, and what strategies can be implemented to enhance their effective management and utilisation in HEIs? Hence, the objectives are to identify the types of enabling resources available in HEIs, explore the challenges faced by administrators and staff in managing enabling resources effectively, and propose strategies and policy recommendations for improving the management and utilisation of enabling resources in higher education.

More specifically, this paper presents a planned roadmap for effectively managing and directing all available human, financial, and physical resources in Higher Education Institutions towards nourishing their core functions, priorities, and activities. Therefore, the paper provides a practical framework and a management instrument for determining how to maximise the use of available enabling resources in Higher Education Institutions to remain viable in the continuously changing and competitive environment of higher education.

SWOT Analysis

SWOT analysis aims to identify the strengths and weaknesses of an institution and the opportunities and threats in the environment. Having identified these factors, strategies are developed which may build on the strengths, eliminate the weaknesses, exploit the opportunities, or counter the threats.

The strengths and weaknesses are identified by an internal appraisal of the institution, and the opportunities and threats by an external appraisal. The internal appraisal examines all aspects of the institution, covering, for example, personnel, facilities, location, products, and services, to identify the institution's strengths and weaknesses. The external appraisal scans the political, economic, social, technological, and competitive environment to identify opportunities and threats (Baban, 2018b).

A benefit of using SWOT analysis is the ability to connect internal and external factors to facilitate new strategies. Thus, resource and competency-based planning can enrich SWOT analysis by developing the internal perspective while maintaining both internal and external perspectives concurrently. Furthermore, SWOT analysis serves as the foundation for resource and competency-based planning. Similarly, scenario planning appears to be a rather different technique at first glance. However, scenario analysis emphasises the external environment and identifies key external factors like the external appraisal of SWOT analysis. The creation of scenarios can therefore also enhance SWOT analysis (Baban, 2018b).

SWOT analysis is often presented as a method for rapidly moving toward an agreed-upon strategy. While it can certainly aid in generating new strategic initiatives, a strategic development process also requires considerable analysis and testing of new initiatives before adoption. This testing should be conducted against all developed scenarios where they exist, and a financial evaluation would certainly be advisable, if not mandatory. Important developments to the SWOT approach have involved prioritising the various factors generated and adding a feedback loop in the strategy generation process to ensure that high-scoring factors are addressed by the strategic initiatives. This is crucial for ensuring that significant weaknesses and threats are not overlooked and that the institution's potential is fully realised. Furthermore, SWOT analysis has stood the test of time and can readily incorporate ideas from newer approaches, such as resource- and competency-based planning and scenario development. Crucially, however, it keeps internal and external factors in focus simultaneously (Dayson, 2004; Baban & Rafik, 2024).

In terms of higher education applications, SWOT analysis serves as a planning tool for identifying the strengths, weaknesses, opportunities, and threats facing the management of enabling resources in a HEI (Learned et al., 1965; Dyson, 2004; Baban, 2018b; Baban & Rafik, 2024). Therefore, it entails specifying the organisation's objective and identifying the internal and external factors that are favourable or unfavourable in achieving that objective (Cheng-lin & Chen Jian, 2016).

The SWOT analysis for developing and implementing a HEI's enabling resources strategies can be briefly conceptualised as (Baban, 2018b; Baban, 2024a; Baban and Rafik, 2024):

i. Strengths: characteristics of the HEI's use of its human, financial, and physical resources that give it an advantage over other universities at present and in the future.
ii. Weaknesses: characteristics of the HEI's use of its human, financial, and physical resources that place it at a disadvantage relative to other Universities at present and in the future.

iii. Opportunities: elements of the HEI's use of its human, financial, and physical resources that the HEI could exploit to its advantage at present and in the future.

iv. Threats: elements of the HEI's use of its human, financial, and physical resources that could cause it difficulties and challenges at present and in the future.

A Practical Approach for Developing Enabling Resources Strategies

The successful implementation of a HEI's strategic plans for its core functions of Teaching and Learning, Research, and Consultancy depends on the effective and timely coordinated support provided by the enabling plans for human, financial, and physical resources within the institution (Chaffee, 1984; Gumport & Sporn, 1999; Hinton, 2012; Baban, 2017, 2018a). Essentially, this method involves developing the institution's plans while maintaining a comprehensive understanding of its resources (such as cash, assets, and employees), its environment (including markets, political and economic issues, customers, and competitors), and the expectations of the institution's stakeholders (anyone with an interest in the business, such as shareholders, staff, customers, government, etc.).

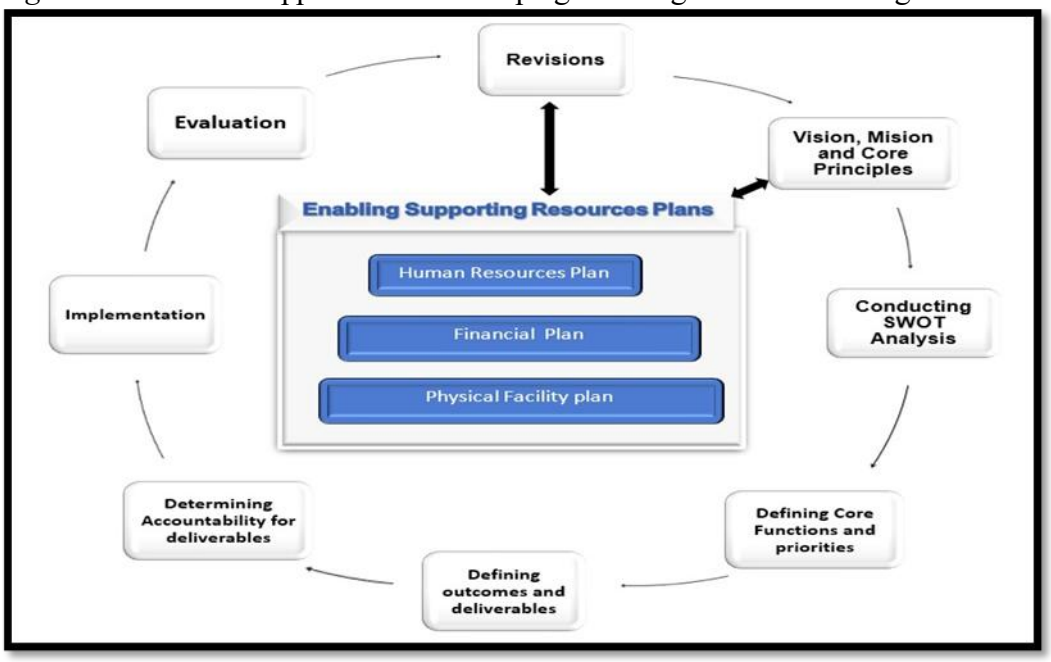
Strategic planning for enabling resources can be developed with two focuses, first a focus on internal pressures, which bases the planning on institutional values, and is purely practical, seeking to assist the HEI in running efficiently and effectively. The other focus is related to positioning the HEI in relation to its external environment, emphasising planning in response to financial changes, government regulations, changes in the student market, competition from other universities, emerging technologies, or international pressures (West-Burnham, 1994; Gumport & Sporn, 1999; Bayenet et.al., 2000; Baban, 2018a; Baban, 2024a; Larsen & Langfeldt, 2005).

The process will require developing a resource management vision for the organisation's future and determining the necessary priorities, procedures, and operations to achieve that vision (Figure 2). In addition, the plans should include measurable goals that are realistic and attainable. There is also a need for detailed action to implement the plans, define management responsibilities, and provide specific points of reference and guidance during the implementation period (Hinton, 2012; Baban, 2017; Baban & Rafik, 2024). More specifically, the planning process can proceed through determining the following steps (Neumann & Guthrie, 2006; Baban, 2017; Hinton, 2012; Baban, 2018b; Baban & Rafik, 2024).

i. **Defining vision, mission, and core principles.** This involves articulating the mission and expected objectives that clearly express what the HEI must achieve to address priority issues related to human, financial, and physical resources. This establishes the direction of the institution for the long term and clearly defines the relevant markets, customers, products, and vision by conceptualising what the organisation's future should or could be. In turn, this will determine the HEI's niche and competency within its geographic and virtual environments.

ii. **Conducting SWOT Analysis for Enabling Resources**. To identify the institution's strengths, weaknesses, opportunities, and threats facing Human, Financial, and Physical Resources at the HEI.

Figure 2. A Practical Approach for Developing Enabling Resources Strategies



This process will provide a realistic understanding of the demand for HEI education based on graduate profiles, including employability skills, the HEI's real competencies, as well as the actual and potential competitors in the field.

i. **Prioritising Human, Financial, and Physical Resources Issues**. The process requires precise planning to direct the utilisation of all available enabling resources to support HEIs' core functions, priorities, and activities. The ultimate aim is to ensure the institution's relevance and viability in the future. Hence, identifying priority human, financial, and physical resources is significant to the overall well-being of the HEI and will require the consideration of the entire management team. The key priorities for allocating enabling resources in HEIs should include alignment with HEIs' core functions, priorities, activities, and the capacity to amplify the delivery of the aforementioned core functions, priorities, and related activities. In addition to supporting compliance, safety, and/or risk mitigation, as well as leveraging additional resources.

ii. **Determining Accountability.** Identifying the accountable personnel and the relevant timelines for implementing the enabling resources management strategies, action plans, and budgets, and effectively communicating the process of allocating resources (time, human capital, and funds) to address the priority issues and achieve the defined objectives.

iii. **Reviewing.** The HEI should schedule regular reviews to ensure that the enabling resources strategies are effectively supporting the HEI's mission and expected objectives as intended and, if necessary, to refine the human, financial, and physical strategies as required.

Developing a Human Resources Strategy

Human capital, encompassing academic and administrative staff, directly influences teaching quality, research productivity, and institutional reputation (Ngare, 2023). Human resources are the most valuable assets for higher education institutions. Therefore, a practical plan is necessary to fully benefit from these resources. Human Resource Planning in the context of higher education is a systematic and logical approach to organising various levels of personnel to guide, coordinate, and manage interpersonal and personnel duties, as well as oversee professional activities. Additionally, it aims to efficiently manage a broad range of functions, including employment, recruitment, rewards, appointments, and assessments of faculty and staff in accordance with the laws, regulations, and policies to retain and attract talent (Rafik & Baban, 2024).

The planning process ensures that enough qualified academics, managers, and administrators are present to successfully deliver the required outcomes from learning and teaching, research, consultancy, and service to all stakeholders. Therefore, it will focus on demand and supply forecasting, which involves obtaining accurate information about current staffing levels, determining the number and type of staff required by the institution based on future goals, growth expectations, and curriculum changes. Simultaneously, it should assess the supply of available talent by evaluating the current workforce and identifying any gaps in skills or qualifications. These gaps may necessitate requirements for training and development to upskill existing staff or the recruitment of new staff with the necessary expertise.

The plan will also emphasise the importance of developing an employment strategy to fulfil the identified staffing needs through means such as internal promotions, recruitment from external sources, and talent development initiatives. Another aspect is planning for training and development programs to help employees improve their skills, stay updated with the latest educational technologies, and prepare to meet the evolving demands of higher education. Furthermore, the plans will require continuous evaluation to assess how well they are being executed and whether the staffing levels and skills align with institutional needs. Periodic reviews should be conducted to determine if there is overstaffing or understaffing, or if additional skills are needed due to changes in the educational landscape. This stage often leads to adjustments in the initial plans, including new hiring or retraining efforts (Baban, 2018b; Baban & Rafik, 2024).

Overall, the planning process must focus on aligning the human resources of an institution with its goals and objectives. In principle, it represents the connection between the educational institution's needs and the supply of qualified individuals to fill roles within it. Without this foresight, higher education institutions may struggle

to maintain the quality of education, research, and administrative operations (Taylor et al., 2008; Gumport & Sporn, 1999; Baban, 2018a, 2024).

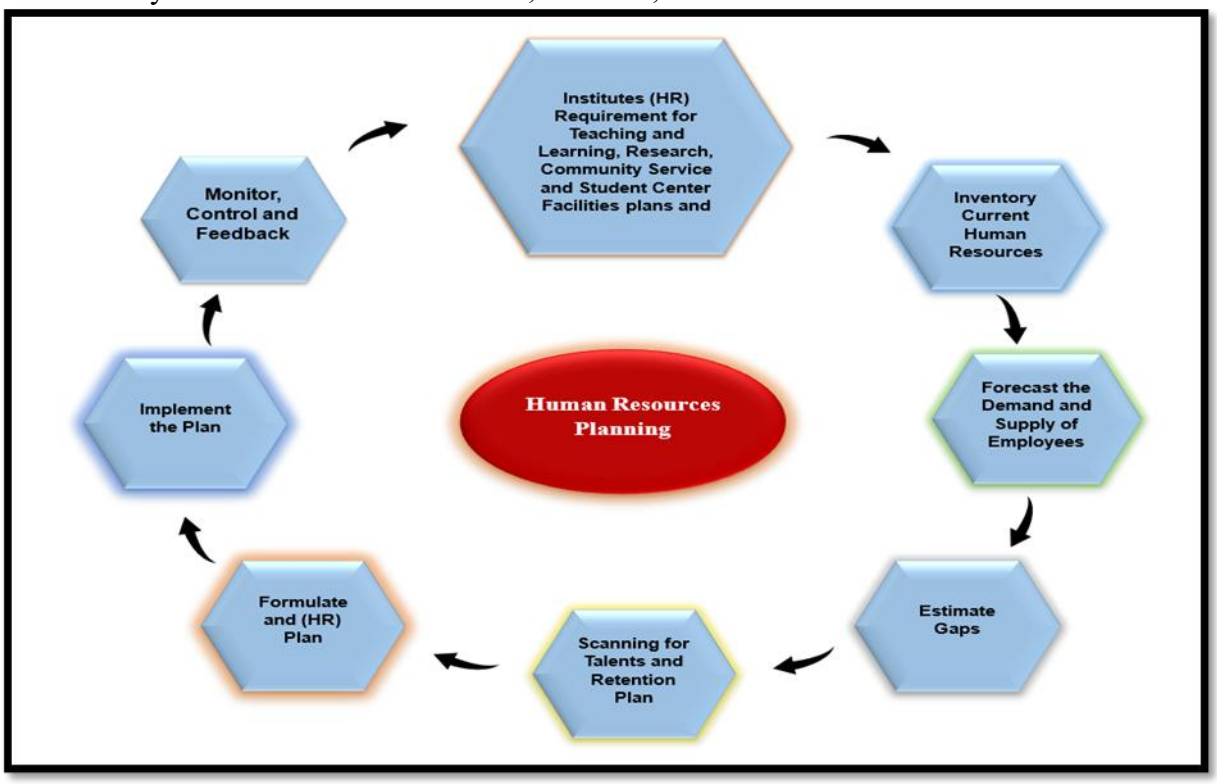
Effective Human resources planning will enable the successful delivery of the institute's core functions, priorities, and related activities through:

i. Providing valuable insights into the workforce and making informed decisions about organisational structure, resource allocation, and strategies.
ii. Identifying skill gaps and providing targeted training and development opportunities for employees.to increase employee satisfaction, motivation, productivity, and performance.
iii. Anticipating and addressing future workforce needs through analysis of the workforce and forecasting future needs.
iv. Identifying critical roles, developing potential successors, and facilitating a smooth transition of leadership and continuity in operations.
v. Creating a positive work environment, promoting employee engagement and satisfaction. Hence, aiming to both attract and retain top talent,
vi. Managing workforce costs by avoiding overstaffing, understaffing, and identifying opportunities to optimise the workforce structure and performance.
vii. Mitigating the risks associated with workforce disruptions and developing contingency plans to handle potential challenges such as labour shortages, changes in labour laws and regulations.

In a practical sense, the planning process often involves gathering data to identify future gaps and surpluses in the workforce, population demographics, as well as turnover rates and their causes. The institution's mission, strategic objectives, and government employment laws and regulations must also be considered. Then, the institution will need to develop a Human Resources Strategy to address the identified needs for the successful accomplishment of an organisation’s mission and strategic objectives (Taylor et al., 2008; Gumport & Sporn, 1999; Baban, 2018a).

The process starts by developing an inventory for current human resources, forecasting the demand, and estimating gaps. These are followed by scanning for talents and developing retention polices. Then, a plan is developed, implemented, and monitored for adjustments to meet institutional needs (Figure 3).

Figure 3. Developing and Implementing a Human Resources Plan to Support and successfully deliver HEI's Core Functions, Priorities, and related Activities



Physical Facilities Planning

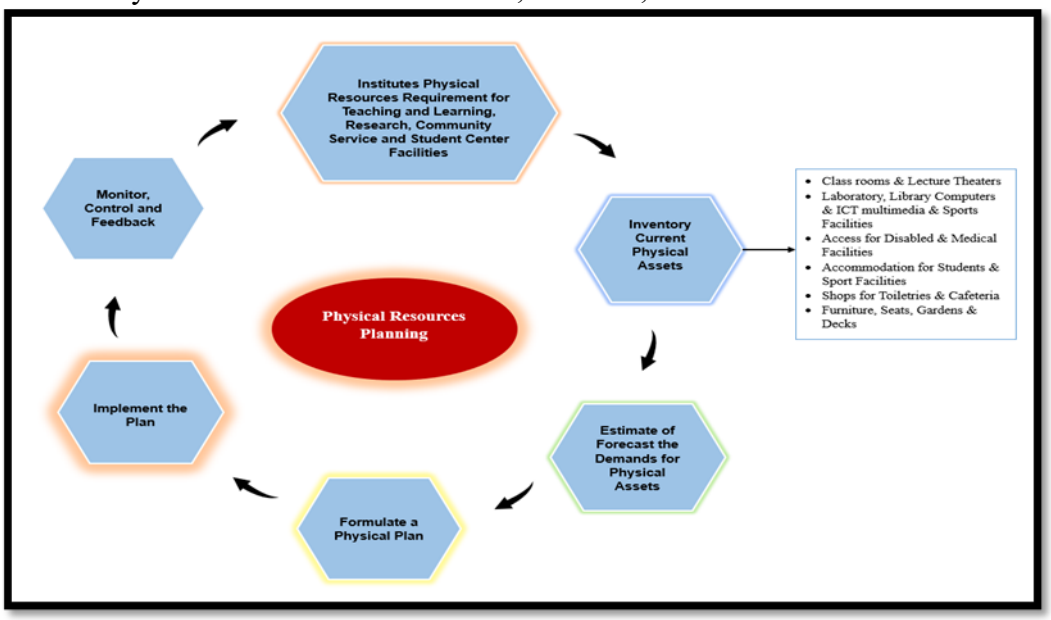
The physical assets and facilities refer to resources that contribute directly or indirectly to creating an optimal environment and atmosphere for quality teaching, learning, research, consultancy, and outreach activities within a higher education institution. These include buildings, classrooms, hostels, staff quarters, workshops, laboratories, ICT centres, libraries, health centres, and sports facilities. Facilities that promote a learning environment and ensure safety are also major considerations in developing physical assets and facilities. Additionally, investing in environmental beautification and sanitation is deemed necessary to create an aesthetic impression that guarantees tranquillity and favourable surroundings for teaching, learning, and research activities. These factors, along with timely and cost-effective maintenance and renewal of all these assets, are crucial (Musa & Baharum, 2012; Baban, 2018b; Baban & Rafik, 2024).

Increasingly, the state of facilities in higher education is becoming an indicator of the overall health of an institution and its readiness to move into the next decade and to fulfil its strategic ambitions to remain both relevant and competitive whilst confronting the shifting paradigm underway in higher education. Hence, with advancements in technology and shifting educational paradigms, institutions must adapt their physical and virtual infrastructures to meet the needs of modern students and faculty.

Research has increasingly focused on sustainable and flexible design of learning spaces, with smart classrooms and green campuses emerging as themes (Temple, 2018). Physical facilities planning in higher education involves long-term planning and management aimed at developing and maintaining high global standards for physical assets and facilities, in alignment with the institution's mission, vision, and goals. Thus, it encompasses space utilisation, campus development, maintenance, and sustainability initiatives. Naturally, this is a complex, cost-intensive, and very challenging process. Therefore, the need for physical facilities planning is paramount for creating an environment conducive to supporting and successfully delivering HEIs' core functions, priorities, and related activities (Baban 2018b; Baban & Rafik, 2024).

In practical terms, the process starts by developing an inventory for current physical assets, forecasting the demand, and formulating a physical plan. Then the plan is implemented and monitored for adjustments to meet institutional needs (Figure 4).

Figure 4. Developing and Implementing a Physical Resources Plan to Support and successfully Deliver HEI's Core Functions, Priorities, and related Activities.



Financial Resources Planning

Financial planning is essential for HEIs, especially during times of uncertainty and change. It guarantees an institution's capacity to uphold a positive financial status while effectively supporting its core functions, priorities, and related activities.

All Higher Education Institutions (HEIs) aim to realise financial sustainability, which is to have the ability to maintain their financial viability and existence over time. However, challenges often arise from reliance on tuition fees, inflation, rising prices, and inadequate facilities. In addition, global pandemics, wars, and political conflicts will lead to inevitable, impactful changes in HEIs, including decreased

student intakes and diminishing government funding. Achieving financial sustainability in HEIs can be attained by incorporating the concept of sustainability into the plans and operations at all levels through, for example, diversifying revenue streams, reducing costs, improving performance, making long-term investments, and employing data-driven decision-making.

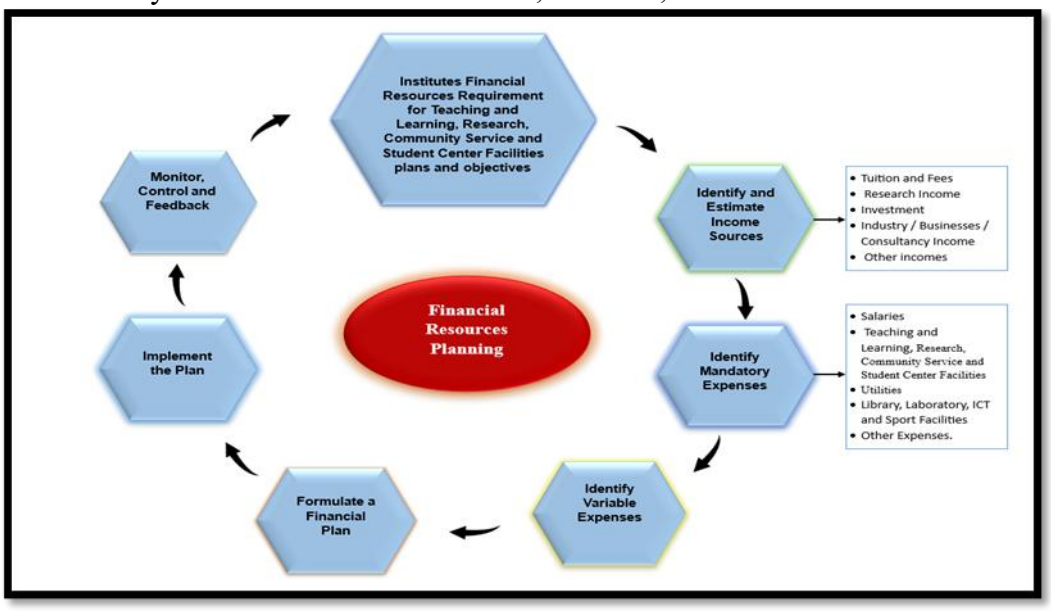
The literature consistently reveals tensions between rising costs, reduced public funding, and growing demands for accountability (Johnstone, 2019). Empirical research demonstrates that financial resource scarcity constrains infrastructure development, technological adoption, and staff recruitment (Salmi, 2020). Nonetheless, most studies remain macro-level and policy-focused, documenting funding sources without assessing how resource distribution affects institutional efficiency or learning outcomes. Only a few adopt performance-based or return-on-investment analyses (OECD, 2020; Sunder, 2022).

Financial Resources Planning in HEIs can assist greatly in achieving financial sustainability by building financial considerations into all key decision-making processes is essential. Hence, it focuses on optimising revenue from student admissions, existing programs, and developing new sustainable revenue streams through research and consultancy activities. Innovation and diversification should be encouraged while ensuring alignment with the HEI's vision and strategic plan. To identify specific strategic, sustainable, and diversified revenue growth priorities, the HEI will need to benchmark its resource capability against local and international universities with which it seeks to compare itself in terms of core functions, priorities, and related activities (Baban, 2018b; Baban & Rafik, 2024).

Furthermore, expenditure should align with strategic goals, ensuring that any growth in expenditure is, at a minimum, matched by increases in revenue. Therefore, there should be a greater focus on managing operating activities within the funds generated and a continuation of strategic cost management programs, along with associated administrative reform and simplification.

In practical terms, the process starts by identifying income sources, mandatory expenses, and variable expenses. These are followed by developing a financial plan, implementing and monitoring the plan for adjustments to meet institutional needs (Figure 5). This process should be supported by transparent budgeting, accountability for financial performance, and an embedded culture of business process improvement to ensure efficiency and effectiveness across the HEI.

Figure 5. Developing and Implementing a Fanatical Resources Plan to Support and successfully Deliver HEI's Core Functions, Priorities, and related Activities.



Implementation Plans

The implementation plans serve as a means to effectively deliver the vision, goals, and objectives outlined in the Human, Financial, and Physical Resources plans on time. However, while creating a strategic plan is important, successful execution ultimately determines an institution's success. Achieving success often hinges on having clear actions, measurable goals, and performance indicators, while making the strategy visible and aligning efforts for implementation (Baban, 2018a, 2018b, 2024a, b). Some actions to ensure successful implementation include (Hinton, 2012; Baban, 2018a, 2018b, 2024a, b):

i. **Gaining Leadership Commitment:** Achieving this commitment to a strategy is essential for ensuring alignment across all levels of an organisation. Hence, leadership should actively participate in planning discussions, publicly state their commitment to the strategic plan, and lead by example in taking ownership of the goals under their purview.
ii. **Aligning all Institutional Plans, Functions, and Activities with Strategic Objectives:** This will ensure that all divisions and decision-makers have clarity on the overall objectives and how their plans and activities contribute to achieving the same end objectives.
iii. **Converting Strategic Intent into Defined Actions:** Operationalising the strategic plan transforms high-level aspirations articulated in the strategy into specific, actionable, and measurable steps that can be executed by employees across levels.
iv. **Driving Accountability Across All Levels:** Establishing accountability requires clearly defining responsibilities related to the strategy and ensuring

follow-through. Each strategic objective and initiative must have an owner responsible for overseeing progress and success. Therefore, a robust review and performance management mechanism will cultivate a culture of accountability throughout the institution's hierarchy. Progress against implementation plans is continuously monitored using relevant key performance indicators and metrics.

v. **Boosting Overall Performance:** Effective implementation also enhances execution capabilities across the organisation, maximises operational efficiencies, and strengthens process compliance, collectively resulting in significant performance gains.

Some of the major obstacles faced during implementation include:

i. **Having Inadequate Resources:** Even the best strategies struggle when teams lack the necessary skills, technology, budget, or capacity to execute assigned initiatives. Pursuing overly ambitious goals without sufficient resources results in failure, frustration, and a loss of credibility in the strategy.

ii. **Lack of Communication:** When communication is inadequate, divisions and decision-makers do not function in harmony, leading to inefficient duplicate efforts, critical gaps falling through the cracks, and an overall lack of cohesion across the organisation. Maintaining open dialogue at all levels ensures transparency when challenges arise so that leadership can quickly reallocate resources in response.

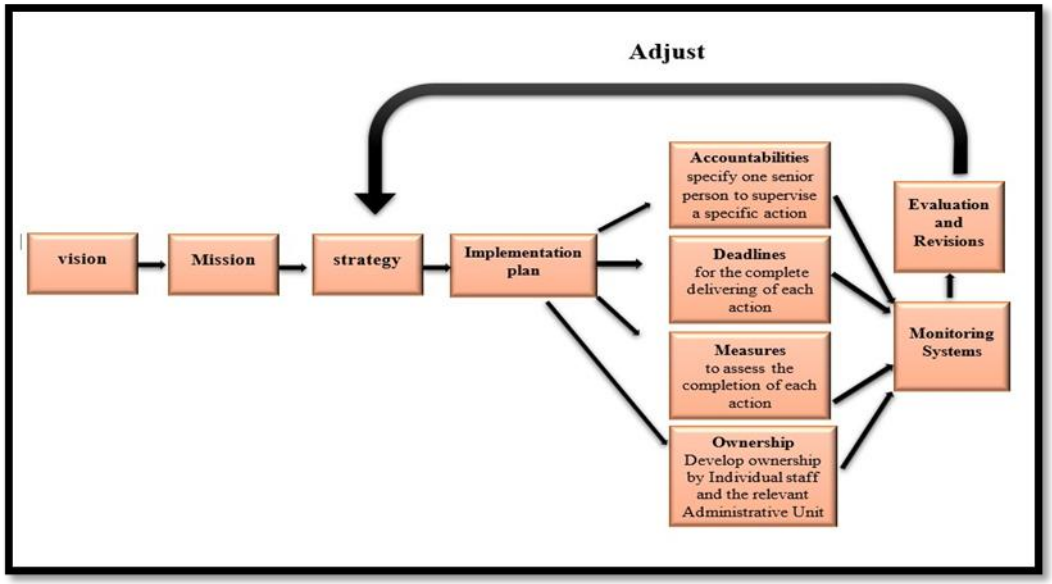
iii. **Poor Performance Tracking:** Not having clearly defined key performance indicators (KPIs) and progress monitoring processes will make it difficult to measure and monitor progress, also it will not be possible to take advantage of the opportunities to adjust the plans when needed.

iv. **Change Resistance:** Changes and strategic shifts will inevitably create resistance due to the need for adopting new mindsets, modifying deep-seated behaviours, and disrupting established norms. Unambiguously dealing with concerns raised by change resisters and pessimists also helps secure their understanding and approval before implementation. Conveying the case for change, depicting a positive and inspirational vision of the future, and outlining the major advantages for employees and the institution's future smooths the path forward.

In practical terms, following certain prerequisites can reinforce implementation and ensure successful outcomes. These include (Gumport & Sporn, 1999; Hinton, 2012; Baban, 2018a, 2018b, 2024a, b):

1. Assignment of responsibility, deadlines, and identification of measures of completion and documentation. Consequently, it is necessary to identify one and only one person to be accountable for supervising a particular action to completion, a date by which the action is expected to be completed, and what measures will be used to assess completion of the action (Fig. 6).
2. The person's assigned responsibilities for the actions must have the authority and the necessary resources (people, time, space, technology, and funding) to deliver the required objectives on time.
3. To facilitate faculty participation, the HEI should target faculty members individually and strive to obtain their commitment, willingness, and a positive collective sense of the need for change. Additionally, it should encourage the organisational units to take responsibility for planning their enabling resources while promoting alignment between unit-level plans and the HEI's overall strategic plan.
4. Strengthen the participation and capacity of managers and implementers. This is necessary to enable the organisational units to successfully fulfil their role in the planning process, and it can be achieved through creating a diverse leadership team with deep organisational knowledge, a variety of perspectives, and an understanding of decision-making powers and boundaries.
5. Conducting a semi-annual review. This review is necessary to transparently examine the outcomes and to adjust the plans as necessary.

Figure 6. The Implementation Process for enabling Strategic Plans (Baban, 2024a)



1. The implementation plan should be flexible in its formation; hence, it can be easily adjusted to respond to concerns about the planning process as well as the internal and external changes that will occur within the duration of the enabling resources plans.
2. HEIs in their early years of strategic planning need to establish feasible goals and action plans, factoring in the changes associated with mobilising and managing human as well as financial resources.

Conclusions

Higher education institutions increasingly face challenges in remaining relevant and competitive while enhancing and delivering their core functions of learning and teaching, research, consultancy, and community service. These challenges can be addressed by modernising the institution's vision and programs, utilising new approaches to learning and teaching, and energising research, consultancy, and community services. However, these efforts are often not fully realised, partly due to inadequate management for human, financial, and physical resources, which potentially can provide flexible means for operating competitively in complex organisations like HEI's which need ongoing revitalisation to remain relevant and competitive.

An evaluation of literature reveals that while human, financial and physical resources each play indispensable roles in HEIs, research on their utilisation is fragmented, uneven, and theoretically underdeveloped. Human and technological resource studies dominate contemporary discourse, whereas financial and physical resource analyses remain descriptive. The challenge ahead is to move towards integrated, evidence-based, and context-sensitive approaches that conceptualise HEIs as complex adaptive systems. By aligning these resources strategically and sustainably, institutions can enhance their educational quality, resilience, and social impact.

This paper presents a process for developing and implementing strategic plans for human, financial, and physical resources in Higher Education (HE) to support and enable the delivery of the institution's foresight for its declared objectives, including core functions. The paper, as a prerequisite, promotes establishing collective institutional agreements on the institution's operating principles, priorities, and fundamentals to allocate and ensure the availability of all the necessary resources when they are needed at the HEI, college, and department levels. Hence, the leadership should focus on aligning the necessary human, financial, and physical resources allocations and cultivating new resources to support the key priorities in the HEI strategic plan.

Experience shows that the planning process and associated procedures can help guide senior management and empower middle managers in organising and allocating their resources to deliver the institution's daily core activities and broader aims. Furthermore, the developed plans provide specific points of reference and guidance during the planning process and the implementation period. In addition to monitoring progress, they detect deviations from the plan and correct them promptly. Having

strategic plans also provides direction for the institution and gives staff members a sense of shared responsibility, allowing managers to make resource allocation decisions according to clearly defined goals, establishing a measure for success by comparing growth and performance to predetermined objectives, and enhancing institutional adaptability to anticipate and meet the changing demands of the market.

The novelty of this research can be characterised as providing a comprehensive view of enabling resources by presenting a holistic framework that integrates human, financial, physical, technological, and informational resources as interconnected enablers of institutional performance. Furthermore, the work has a specific focus on higher education, which remains under-researched in resource management, especially in developing or resource-constrained contexts.

In terms of contributions to knowledge and practice, the research develops a conceptual framework to effectively manage enabling resources' influences in HEIs' performance, determined by leadership and governance practices. Besides providing practical recommendations for achieving sustainable resource management, promoting accountability, enhancing institutional resilience through better planning and resource utilisation, and contributing to the overall quality of higher education by improving teaching, learning, and research environments.

1. In terms of implications for practice, the paper encourages strategic resource allocation through empowering administrators to align resources (human, financial, technological) with institutional goals to improve efficiency and outcomes. It also supports monitoring and evaluation systems through implementing systematic tracking of resource utilisation to identify gaps, reduce waste, and optimise performance. Regarding implications for policy, the research encourages policymakers to use evidence-based budgeting and adopt transparent and data-driven approaches for allocating enabling resources across departments and institutions. It also establishes clear guidelines for managing enabling resources, including roles, responsibilities, and accountability mechanisms. In addition to promising performance incentives through connecting effective resource management, institutional outcomes, encouraging efficiency, and innovation. It also encourages sustainable and equitable use of resources, ensuring all units and students have fair access to enabling resources.
2. Implications for future research include comparative studies: examining differences in resource management strategies between public vs. private higher education institutions, or across countries; impact and performance studies: investigating the long-term impact of effective resource management on institutional performance and student outcomes. In addition to sector-specific resource management, examining how specific types of resources (e.g., human capital, ICT infrastructure, laboratory facilities) affect performance outcomes. Also, policy impact studies: assessing how national or institutional policies influence resource management practices and overall higher education quality.

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