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School voor Educatieve Studies

Educatieve master in de wetenschappen en technologie

Masterthesis

The Road to Success: Exploring How Prior Knowledge Shapes Academic Performance in Rehabilitation Sciences

Michael Stouten

Scriptie ingediend tot het behalen van de graad van Educatieve master in de wetenschappen en technologie, afstudeerrichting wetenschappen

PROMOTOR :

Prof. dr. Anouk AGTEN

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MASTERTHESIS

Academic year: 2023-2024

Promotor: Prof. Dr. A. Agten

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CONTENT

ABSTRACT

In recent years, higher educational institutions worldwide have witnessed a troubling increase in dropout rates among first-year bachelor students. This issue has drawn significant attention of policymakers, educators, and researchers. The cause of this dropout phenomenon is complex, encompassing multiple factors. Inadequate alignment between secondary school education and tertiary education demands, or mismatches between student expectations and program offerings, are potential contributors. Additionally, gender, socioeconomic status, ethnic background, physical and mental health, and prior knowledge play crucial roles in influencing dropout rates.

This study has two research objectives. The first objective is to investigate the influence of prior knowledge on academic success within the Physiotherapy and Rehabilitation Sciences (PRS) program at the University of Hasselt. The new curriculum, introduced in 2018, comprises four major program-related courses. Pearson's correlation analysis assessed the correlation coefficients between chemistry, physics, and mathematics prior knowledge tests and performance in program-related courses. The results indicate that prior knowledge of mathematics and physics is essential for succeeding in these courses, particularly for passing biomechanics in kinesiology (KIN).

The program-related courses consist of smaller units, i.e. subunits, each contributing a partial score to the overall program-related course. However, failure in these subunits requires students to retake the entire program-related course in the following academic year. Consequently, as a second objective, this study also investigates the impact of specific subunits on student progression. A descriptive analysis revealed that biomechanics in kinesiology 1 (KIN1) disproportionately affects the progression of PRS students, significantly contributing to delays and increased dropout rates.

In conclusion, this study demonstrates a correlation between the prior knowledge domains mathematics and physics and success in the subunit biomechanics within the KIN-related course. Furthermore, the biomechanics subunit is a major factor negatively impacting student progression and increasing retake rates in the PRS program at the University of Hasselt. Addressing these issues through targeted interventions could enhance student retention and success in tertiary education.

INTRODUCTION

1. First-year dropout dilemma in higher education

In the past few years, there has been an increasing dropout rate of first-year students in higher educational institutions, drawing the attention of educational policymakers, institutions, and researchers (Dropout in het hoger onderwijs, 2023).
According to a report by the Organisation of Economic Co-operation and Development (OECD), 12% of starting bachelor students worldwide disengage from tertiary education before progressing to their second year of study. This number increases to a staggering 20% by the projected end of the standard duration of their program (OECD, 2019). This trend is not limited to global scales but also manifests at the regional level, as evidenced by data from the Department of Statistics of Flanders in Belgium. Their findings for the academic year 2020-2021 revealed that 15% of students pursuing higher education failed to persist beyond the first year (Dropout in het Hoger Onderwijs, 2023). This marks a notable 4% rise compared to the cohorts from 2008-2009.
Further confirming this concerning trend, Eurostat data from 2020 illuminates a significant rise in dropout rates, particularly accentuated within the first year of study (Eurostat, 2020). Such statistics paint a disturbing picture, signalling potential inadequacies within the educational framework. The root causes of these dropout phenomena are multifaceted and complex, ranging from students' failure to meet academic prerequisites to discrepancies between educational program offerings and students' expectations or labour market demands, as highlighted by the OECD in 2009 (OECD, 2009).
Consequently, there is a growing imperative for higher educational institutions to redouble their efforts in envisioning comprehensive strategies to foster academic success and mitigate dropout rates among their first-year students (Dropout in het Hoger Onderwijs, 2023). This increasing awareness underscores the need for proactive interventions and targeted initiatives within educational programs to address the underlying factors contributing to student disengagement. By cultivating an environment conducive to learning, enhancing academic support structures and aligning curricular offerings with evolving educational and market demands, institutions can proactively confront the challenge of student dropout and nurture a culture of persistence and achievement (Pont et al., 2008).

2. Secondary schools' influence on tertiary pathways

To grasp the complex reasons behind the rising dropout rates in higher education, it is crucial to thoroughly explore the different factors influencing students' academic journeys and achievements. Beginning with students' initial steps into tertiary education, recent studies have highlighted the significant influence of secondary educational institutions. They play a pivotal role in steering students towards appropriate tertiary education paths, thereby reducing the likelihood of dropouts and promoting long-term academic success (Eriksson et al., 2018; Howard, 2010; Howard et al., 2015; Morgan et al., 2018; Osman, 2022; Pisa, 2018; Tierney et al., 2009).

2.1. Skills and knowledge

A nuanced investigation into students' decision-making processes regarding their choice of tertiary education program reveals a complex interplay of multifaceted factors. Osman's (2022) study underscores the significant influence exerted by several determinants, including subject combinations offered in secondary school, personal interests and career

aspirations. For instance, a student aspiring to pursue an accounting program at the tertiary level must possess a foundational background in accounting and mathematics. This highlights the critical role of secondary education in equipping students with the requisite skills and knowledge (Osman, 2022).

Moreover, insights from the OECD Programme for International Student Assessment (PISA) in 2018 illuminate the challenges Belgian adolescents face in delineating their future career paths, with a ratio of one in three adolescent students lacking clarity due to indecisions or consideration of multiple options. Compounding this issue is the observation that students' career aspirations often diverge from the evolving demands of the job market, suggesting a disconnection between educational pursuits and economic realities (PISA, 2018).

Central to addressing these challenges is the pivotal role of high schools in nurturing students' decision-making skills and fostering informed choices regarding education and career pathways. Eriksson et al. (2018) advocate for holistic interventions integrating group-based and individual activities facilitated by teachers and guidance counsellors to enhance students' understanding of the labour market and educational opportunities. Clear discussions about roles and responsibilities are crucial, particularly regarding self-awareness and decision-making skills. However, educators and counsellors should be mindful of how their cautiousness in discussing alternatives can influence students' future career choices (Eriksson et al., 2018).

Furthermore, empirical evidence underscores the positive correlation between enrolment in high-rigour courses and subsequent college success, as articulated by Morgan et al. (2018). This underscores the importance of secondary schools in providing rigorous academic preparation and support to equip students with the requisite skills and competencies for tertiary education (Morgan et al., 2018).

2.2. Navigating college readiness: strategies for secondary schools

Tierney and colleagues' (2009) seminal work provides a comprehensive blueprint for secondary schools aiming to bolster their students' readiness for the rigours of a college education. Their five key recommendations serve as a foundational framework, emphasising the multifaceted nature of college preparation and the crucial role of secondary institutions in facilitating students' seamless transition into tertiary education.

The first recommendation underscores the imperative for secondary schools to overhaul their courses and curricula to align with the demands of college education. This entails implementing comprehensive programs to equip all students with adequate academic and cognitive skills essential for college success. Moreover, there is an emphasis on ensuring that students grasp the intricacies of a college-ready curriculum as early as the 9th grade, setting a solid foundation for their subsequent educational journey. By embedding college preparatory elements within the curriculum, schools can instil a culture of academic excellence and aspiration among their student body (Tierney et al., 2009; Howard et al., 2010).

Building upon this foundation, Tierney et al. advocate for integrating ongoing assessments to identify and address student preparedness deficiencies for college. Through diagnostic evaluations and personalised interventions, educators can tailor their instructional approaches to meet the diverse needs of individual learners, thereby maximising their potential for success in higher education. This tailored approach mitigates the risk of attrition and cultivates a growth mindset conducive to lifelong learning.

Central to fostering a college-going culture within secondary schools is cultivating supportive networks comprising alumni, professionals, and community stakeholders. By

leveraging these resources, schools can provide students with invaluable mentorship, guidance, and exposure to real-world experiences, thereby shaping their college aspirations and expectations. Moreover, these networks serve as conduits for invaluable insights into the college application process, scholarship opportunities, and career pathways, empowering students to make informed decisions about their educational futures.

Additionally, secondary schools are encouraged to actively facilitate the college entry process by assisting students in navigating the myriad steps involved, such as organising college visits, facilitating entrance exams, and navigating the intricacies of the application process. By demystifying these procedures and providing hands-on support, schools can alleviate the anxiety and uncertainty associated with college admission, empowering students to pursue their academic aspirations with confidence and conviction.

Finally, Tierney and colleagues underscore the importance of promoting financial literacy and awareness among students and their families. Given the significant financial investment associated with higher education, schools must equip students with the requisite knowledge and skills to navigate the complexities of financial aid processes, scholarships, and student loans. By fostering a culture of financial responsibility and empowerment, schools can mitigate barriers to college access and ensure that all students have equitable opportunities to pursue their educational dreams.

Tierney et al.'s recommendations serve as a comprehensive roadmap for secondary schools seeking to enhance their students' readiness for college. By adopting a holistic approach encompassing curriculum enhancements, personalised support, community engagement, and financial empowerment, schools can empower students to make informed decisions, overcome barriers, and succeed in tertiary education and beyond (Tierney et al., 2009).

In summary, the pivotal role of secondary schools in shaping students' academic trajectories and preparing them for tertiary education cannot be overstated. Through targeted interventions and comprehensive support mechanisms, high schools can play a transformative role in enhancing students' study choices and fostering sustained success in higher education.

3. Driving factors in dropping out of tertiary education

Despite concerted efforts to address the influencing role of secondary educational institutions in dropout rates in tertiary education, a comprehensive understanding of the factors driving academic success remains crucial. Recent research endeavours have delved into the tertiary education landscape to identify critical determinants influencing students' progression and achievement.

3.1. Early detection for tertiary dropout prevention

Early detection of at-risk students is a pivotal aspect in tackling the challenge of dropout rates in tertiary education, as Alyahyan and Düştegör (2020) underscored. By promptly identifying students showing signs of academic struggle or disengagement, educational institutions can intervene proactively. This involves leveraging data analytics, qualitative assessments, and monitoring systems to detect patterns indicating potential challenges. Collaboration among faculty, support staff, and stakeholders is key in developing tailored intervention plans (Alyahyan & Düştegör, 2020). Responsive support services, such as tutoring and counselling, must accompany early detection efforts to effectively address students' needs and promote their academic success.

A pioneering study conducted in Portugal by Gil et al. (2021) utilised a data mining approach to predict first-year students' academic success based on 68 distinct features. Among the recommendations from this study was the establishment of study support groups tailored specifically for students with lower entry grades, underscoring the importance of targeted interventions in enhancing academic outcomes (Gil et al., 2021). Similarly, as elucidated by Bjiu (2019), peer tutoring initiatives have bolstered students' academic achievement and fostered a supportive learning environment conducive to success.

3.2. Gender, socioeconomic status and ethnic background in higher education

Despite the above mentioned responsive support services (Bjiu, 2019; Gil et al., 2020), the persistence of distressingly high dropout rates underscores the need for a deeper exploration of prognostic factors influencing academic success among first-year students. Gender plays a significant role in shaping academic outcomes, as evidenced by a plethora of studies demonstrating that female students tend to outshine their male counterparts in various metrics, including grade point average (GPA) and academic motivation (Akimov et al., 2023; Kuśnierz et al., 2020; Vasconcelos & Almeida, 2018). Female students tend to demonstrate higher levels of commitment and perseverance (Kuśnierz et al., 2020), which translates into a greater likelihood of completing their studies within the expected timeframe (Caponnetto et al., 2021). This consistent pattern underscores the potential influence of gender-related factors on academic performance. However, despite these overall trends, disparities persist, particularly within STEM (Science, Technology, Engineering, and Mathematics) fields, highlighting the higher dropout rates among female students in STEM disciplines (Ingo, 2019). Despite their initial academic achievements, female students in STEM face unique challenges and barriers that contribute to their increased likelihood of disengagement and attrition.

Socioeconomic status significantly impacts academic outcomes, with students from disadvantaged backgrounds encountering systemic barriers that hinder their success. These barriers may include limited access to educational resources, inadequate support systems, and environmental factors that impede learning. Consequently, students from disadvantaged backgrounds often face challenges such as lower academic achievement, higher dropout rates, and decreased opportunities for advancement (Entwisle et al., 2005). Furthermore, the socio-economic framework of students' academic and career aspirations underscores the profound impact of their social networks and school compositions, as elucidated by Howard et al. (2015). Notably, socio-economically disadvantaged students are disproportionately affected by this misalignment, underscoring the imperative for targeted interventions to address equity gaps and foster inclusive educational environments (PISA, 2018).

Besides, ethnic background significantly influences academic success, with research indicating that students from immigrant backgrounds often face higher risks of underperformance and dropout. These students encounter language barriers, cultural adjustment issues, and socioeconomic disparities, contributing to their academic struggles (Nicholls, 2006; Klein & Neugebauer, 2023; Zorlu, 2013). However, targeted support programs have been shown to ameliorate these disparities. This underscores the importance of equity-focused interventions (Sopoaga et al., 2017; Williams et al., 2020).

3.3. Physical and mental health

Another crucial determinant in assessing the high dropout rates is the physical and mental health of the first-year students. Nieuwoudt (2023) revealed a profound disparity in the

well-being of students subjected to a shorter delivery model than those following traditional models. This comprehensive examination indicated that students within a short delivery system experience lower levels of psychological distress and enhanced academic performance. Therefore, such insights suggest that reevaluating current conventional educational programs can lead to better physical and mental health distress, increased academic performance and eventually, lower dropout rates.
Moreover, Shepler and Perrone (2016) highlighted the significant role of health factors in student attrition, advocating for proactive support mechanisms to mitigate preventable health-related challenges that may impede academic progress.

3.4. Prior knowledge and secondary school grades

The correlation between secondary school grades and prior knowledge with academic performance in higher education has been extensively documented in scholarly literature. According to De Koning (2012), a robust relationship exists between performance in secondary education and subsequent achievements in tertiary institutions. Moreover, as elucidated by Minnaert and Janssen (1992), possessing domain-specific prior knowledge is imperative for fostering academic success at the higher education level. Rach and Ufer (2020) provided empirical evidence underscoring the pivotal role of prior mathematics knowledge in predicting success during the initial semester of tertiary education, particularly within mathematics bachelor and mathematics teacher education programs. Furthermore, the indispensability of disciplines such as chemistry, mathematics, and physics in comprehending the intricacies of natural sciences has been emphasised by various researchers (Ashikawa et al., 1991; Puddey & Mercer, 2014; Rach & Ufer, 2020; Hailikari et al., 2008). These foundational subjects lay the groundwork for a solid understanding essential for academic excellence. Since each study program builds upon the foundational principles and theories established in the preceding years of education, mastery of these fundamental disciplines becomes paramount. As highlighted by Hailikari et al. (2008) and Rach & Ufer (2020), proficiency in these areas not only equips students to interpret data and formulate hypotheses but also empowers them to conduct experiments effectively within their respective academic pursuits. Thus, cultivating a strong foundation in these disciplines proves instrumental in nurturing academic prowess and facilitating success in higher education endeavours.
In summary, a nuanced understanding of the multifaceted factors influencing academic success is imperative for devising effective interventions to reduce dropout rates and promote equitable outcomes in tertiary education. By addressing systemic barriers, fostering inclusive learning environments, and providing targeted support, educational institutions can empower students to realise their full potential and thrive in their academic pursuits.

4. Academic achievement in Physiotherapy and Rehabilitation Sciences

In 2018, the University of Hasselt introduced a new educational curriculum in the 'Physiotherapy and Rehabilitation Sciences' (PRS) program. Despite its innovative approach, concerns have arisen regarding the dropout rates among first-year students, prompting a need for a comprehensive investigation. This curriculum overhaul involved the incorporation of four new program-related courses: 'Kinesiology 1' (Kin1), 'Kinesiology 2' (Kin2), 'Neurological and Internal Systems' (NIS), and 'Biopsychosocial Model in Paediatrics and Geriatrics' (BMPG). Despite the program's ambition, no previous research has examined influences of several factors on academic success and progression.

Therefore, this study has two research objectives. Firstly, it explores the correlation between prior knowledge assessments in mathematics, biology, and chemistry and first-year students' academic achievement in the PRS program. Secondly, it seeks to discern how failing specific subunits affects students' academic progression.

To delve into the dynamics of this cohort of students entering the new curriculum at the University of Hasselt, comprehensive data on prior knowledge assessments and study results are being collected. This dataset will be analysed to gain insights into the existing baseline of students' prior knowledge and its implications for their academic trajectory within the PRS program. By probing these factors, the study aims to inform targeted interventions and support mechanisms to enhance student success and retention within the program.

MATERIAL AND METHODS

Study design

A comprehensive retrospective study was conducted to delve into the interplay between prior knowledge and the impact of extensive courses on academic performance. The research was designed to study the academic progress of students enrolled in the first bachelor year of the Physiotherapy and Rehabilitation Sciences (PRS) program at Hasselt University during the academic years of 2021-2022 and 2022-2023. The data was extracted from a database containing records of student performances. Subsequently, to ensure confidentiality and privacy, Prof. Dr. Agten anonymised the data before any statistical analyses were conducted according to the General Data Protection Regulation (GDPR). The anonymisation process removed personally identifiable information, such as name, student number, age, gender, socioeconomic features or religious affiliation. Data was collected for the prior knowledge domains (prior knowledge tests of chemistry, mathematics and physics), and program-related courses (i.e. 'Kinesiology 1' (KIN1), 'Kinesiology 2' (KIN2), 'Neurological and Internal Systems' (NIS) and 'Biopsychosocial Model in Paediatrics and Geriatrics' (BMPG)). However, each course is divided into different subunits. The program-related course KIN1 consists of the subunits 'Anatomy', 'Biomechanics', 'Organisational levels' and 'Practical Sessions'; KIN2 consists of 'Practical Sessions', 'Biomechanics' and 'Anatomy' in the academic year 2021-2022. Also, NIS consists of 'Internal Systems' and 'Neurological Systems'; BMPG consists of 'Written exam', 'Group Assignment Motor' and 'Group Assignment Psychology'. Each subunit counts as a partial score and the final score of the program-related course will be calculated on the weight of each subunit. However, if a student scores less than eight out of twenty in a subunit, they will automatically fail the entire program-related course. In the academic year 2022-2023, the KIN1, KIN2, and BMPG evaluation formats changed. For KIN1 and KIN2, the 'Anatomy' and 'Biomechanic' subunits were combined into one 'Oral exam', while for BMPG, the group assessments were consolidated into one group assignment. The program-related courses during the first and second attempts were indicated as (1) and (2), respectively. Within this curriculum framework, students are afforded to retake exams for the subunits they failed, up to a maximum of two attempts. Subsequently, if unsuccessful after the second attempt, students are required to retake the entire program-related course encompassing the failed subunit.

Statistical analyses

The overall data of students of both academic years was investigated using Spearman's rank correlation coefficient. Since the data was not normally distributed, this statistical test was necessary to provide insights into the strength and direction of correlations. The data was analysed using Spearman's rank correlation coefficient in GraphPad Prism 8.0. A heatmap was designed for each academic year using R studio, version 4.3.3., to visualise the overall correlations. Additionally, an analysis was conducted to determine the impact of large subunits on the students' academic progress with Excel 2023. This analysis calculated the succeeding and failing percentages of students' first and second attempts in a specific academic year. Moreover, also, the succeeding and failing percentage of the third and fourth attempts was analysed by focusing on students which had no prior knowledge results. These students were considered as students following this academic program for the second time. Furthermore, a descriptive analysis was conducted to determine which subunit has the most significant impact on the need to retake an entire program-related course. This assessment involved examining the number of individuals who failed the program-related course and identifying how many of them failed due to a single specific subunit.

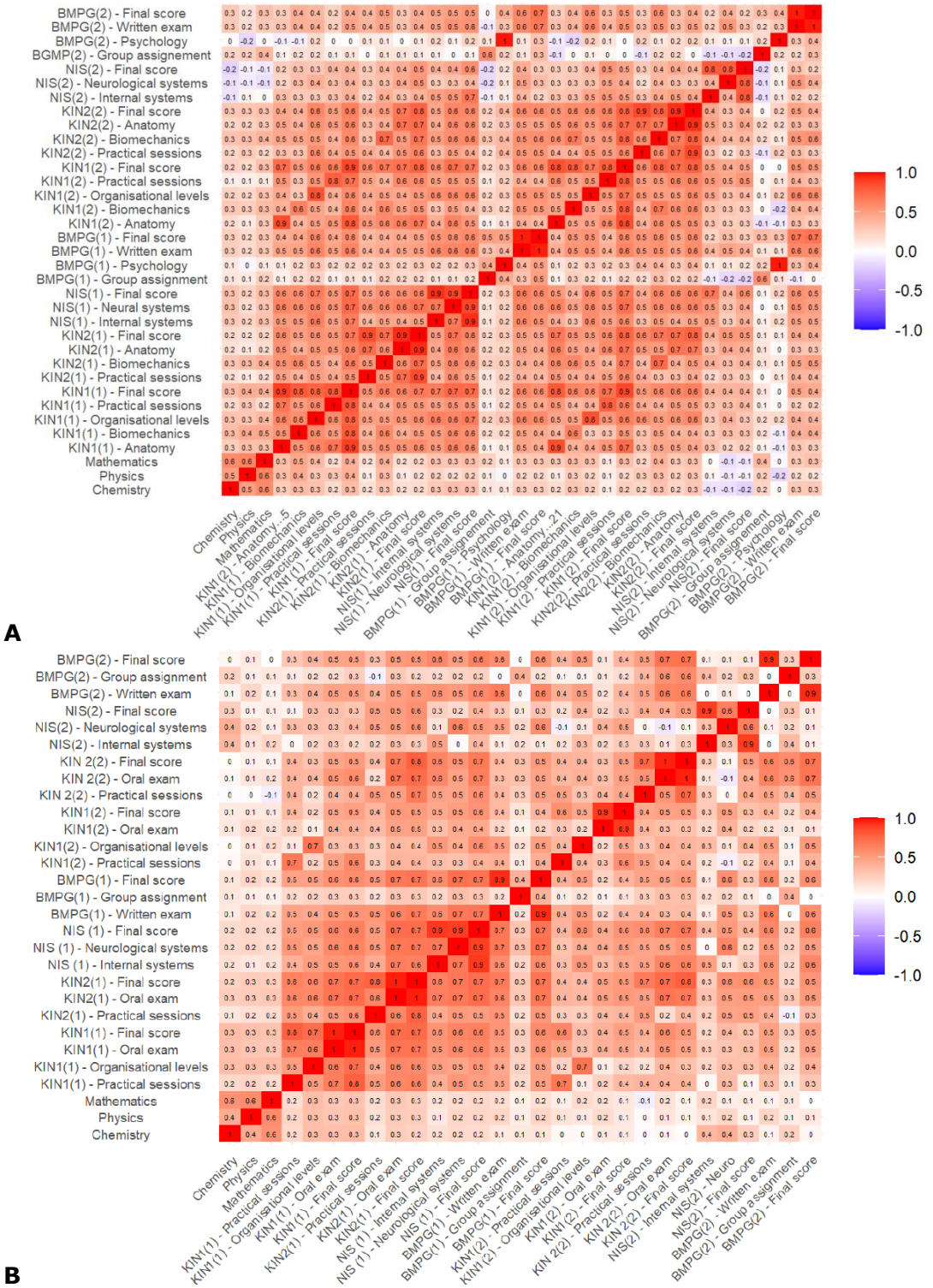
RESULTS

1. The correlation between prior knowledge and exam performance

The Spearman's rank correlation calculated the correlation coefficients (R) between prior knowledge and exam performance of program-related courses within the curriculum of 2021-2022 and 2022-2023. These correlation coefficients were displayed for each academic year independently in heatmaps, figure 1 below. The R values between 0 and 1 presented positive correlations, while those from -1 to 0 exerted negative correlations. However, the R values ranged between -0.2 to 1 and -0.1 to 1 in the academic year 2021-2022 (Figure 1A) and 2022-2023 (Figure 1B), respectively. The correlations between the prior knowledge domains, the specific program-related courses, and their subunits are highlighted in the sections below.

Figure 1

The Correlation between Prior Knowledge Domains and Program-related Courses and their Subunits within the Academic Years 2021-2022 (A) and 2022-2023 (B) of PRS.



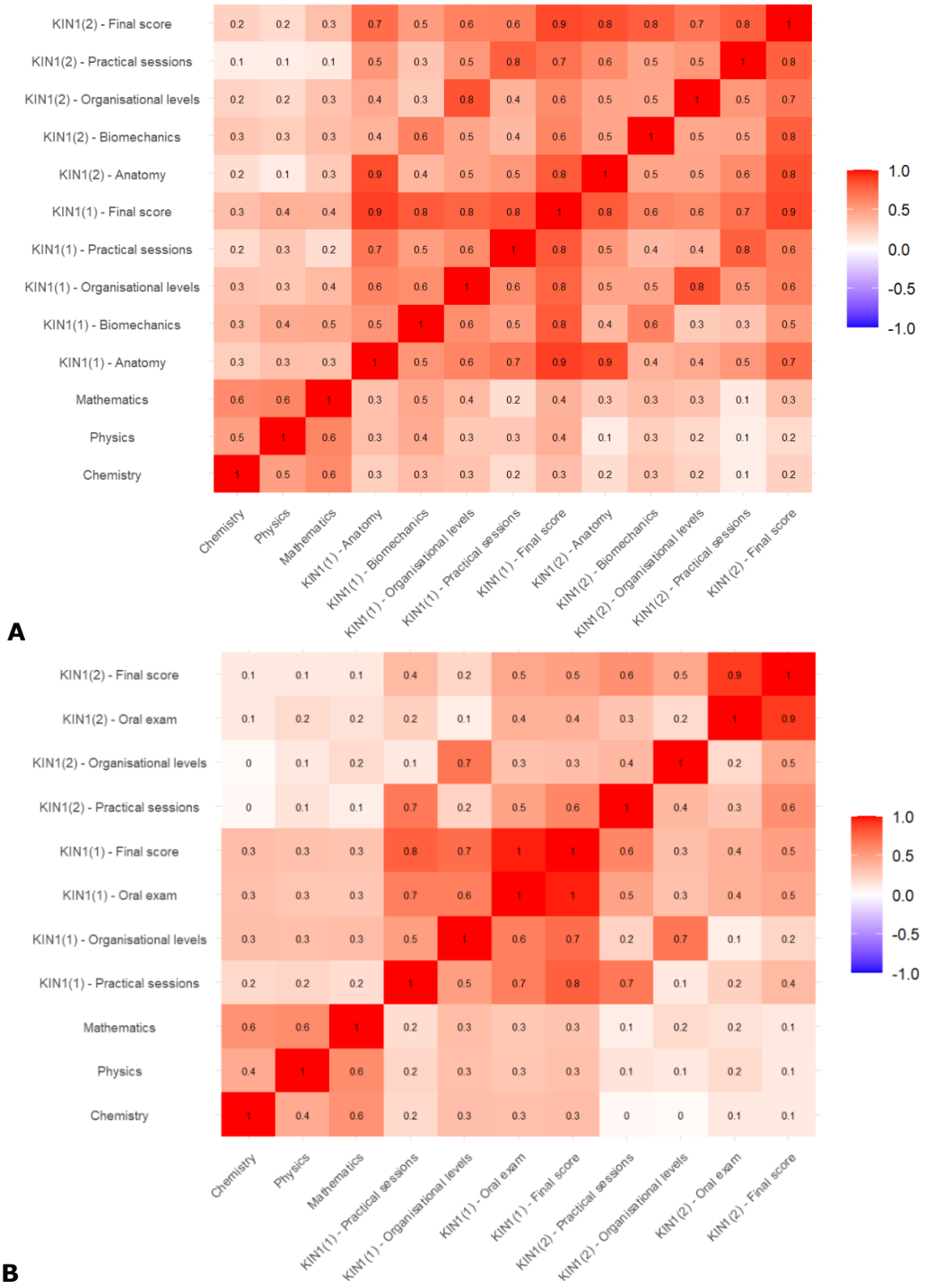
Note. Heatmap of the correlation between prior knowledge domains and exam performance in the first bachelor year of physiotherapy students for the academic year 2021-2022 (A) and 2022-2023 (B). The correlation between the prior knowledge domains chemistry, physics and mathematics with the four program-related courses ('Kinesiology 1' (KIN1), 'Kinesiology 2' (KIN2), 'Neurological and Internal Systems' (NIS), and 'Biopsychosocial Model in Paediatrics and Geriatrics' (BMPG)) and their subunits are displayed. The coefficients close to score 1 are red, indicating a strong positive correlation; those close to score 0 are pink, indicating a weak positive correlation, and the negative coefficients are represented in blue. The subunits during the first and second attempts were indicated as (1) and (2), respectively.

1.1. Correlation between prior knowledge domains and KIN1 in 2021-2022 and 2022-2023

During the 2021-2022 academic year (Figure 2A), the correlation between the prior knowledge domain chemistry and the KIN1 subunits ranged from 0.2 to 0.3 at the first attempt. The correlation with KIN1 subunits is slightly higher for physics, between 0.3 and 0.4. Mathematics shows correlations with KIN1 subunits in the range of 0.2 to 0.5. Higher correlations of 4.0 were revealed between physics and the subunit biomechanics and the final score of the program-related course KIN1. At the same time, mathematics showed the same R value with the subunit organisational levels and the final score. Even more, mathematics presented an R-value of 0.5. In the second attempt, the correlations between prior knowledge and the subunits remain positive but lower, ranging from 0.1 to 0.3. During the academic year of 2022-2023 (Figure 2B), the correlation coefficients between prior knowledge and KIN1 subunits are consistent, ranging from 0.2 to 0.3 at the first attempt. For the second attempt, the correlations are lower, ranging from 0 to 0.1 between chemistry and the subunits and 0.1 to 0.2 for physics and mathematics with the subunits of KIN1.

Figure 2

Correlation between Prior Knowledge Domains and Program-related Course Kinesiology 1 for the Academic Year 2021-2022 (A) and 2022-2023 (B).



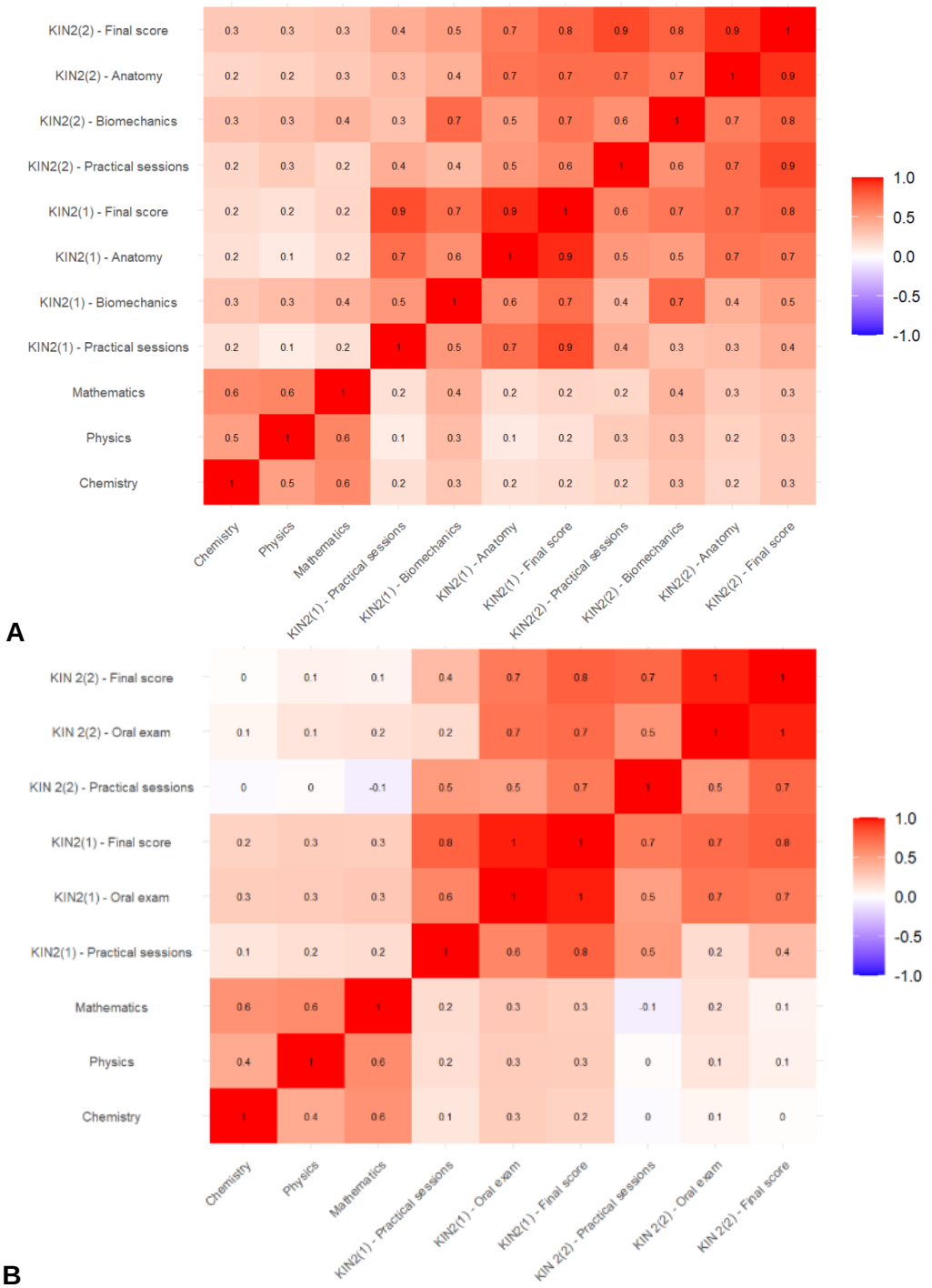
Note. Heatmap of the correlation between prior knowledge domains and the program-related course kinesiology 1 (KIN1) in the first bachelor year of physiotherapy students for the academic year 2021-2022 (A) and 2022-2023 (B). The correlation coefficients between the prior knowledge of chemistry, physics and mathematics and the program-related course KIN1 are shown. The coefficients close to score 1 are red, indicating a strong positive correlation; those close to score 0 are pink, indicating a weak positive correlation, and the negative coefficients are represented in blue. The subunits during the first and second attempts were indicated as (1) and (2), respectively.

1.2. Correlation between prior knowledge domains and KIN2 in 2021-2022 and 2022-2023

In the 2021-2022 academic year (Figure 3A), the first attempt showed positive correlations between chemistry and the subunits of KIN2, with coefficients ranging from 0.2 to 0.3. Physics had correlations with the subunits between 0.1 and 0.3. For mathematics, the correlations varied from 0.2 with anatomy and practical sessions to 0.4 with biomechanics. During the second attempt, these correlations remained consistent, with coefficients between 0.2 and 0.3 for chemistry and physics with the subunits. For mathematics, the correlation with the subunits was 0.2 for practical sessions, 0.3 for anatomy, and 0.4 for biomechanics. The correlation coefficient of 0.4 was consistent between the prior knowledge and biomechanics for the first and second attempts. In the 2022-2023 academic year (Figure 3B), the correlation coefficients between physics, mathematics, and the subunits ranged from 0.2 to 0.3, while for chemistry, the correlations with the subunits were between 0.1 and 0.3 at the first attempt. However, the correlation coefficients were lower in the second attempt, between 0 and 0.1 for physics and chemistry with the subunits and from -0.1 to 0.2 for mathematics with the subunits.

Figure 3

Correlation between Prior Knowledge Domains and Program-related Course Kinesiology 2 for the Academic Year 2021-2022 (A) and 2022-2023 (B).



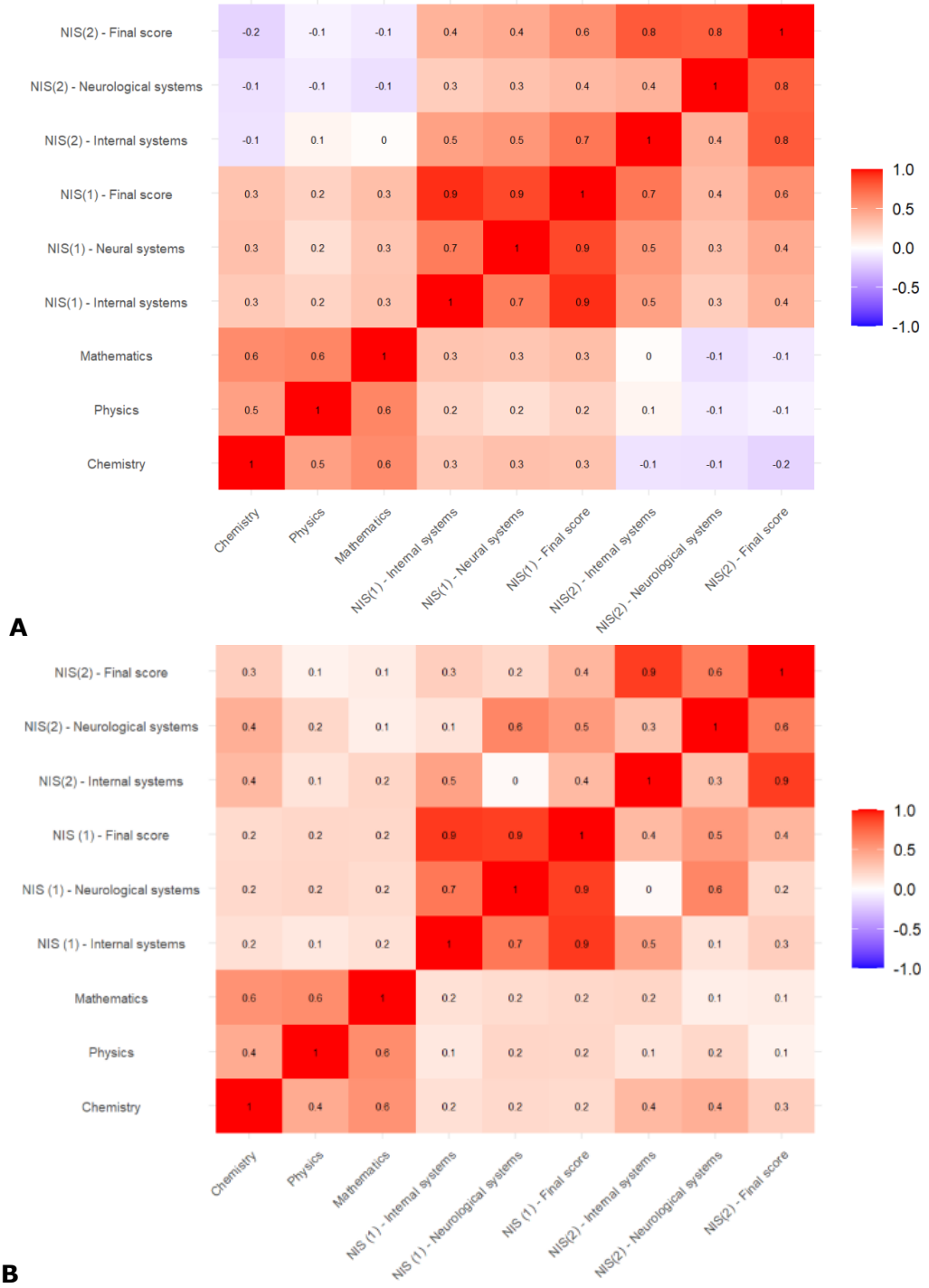
Note. Heatmap of the correlation between prior knowledge domains and the program-related course kinesiology 2 (KIN2) in the first bachelor year of physiotherapy students for the academic year 2021-2022 (A) and 2022-2023 (B). The correlation coefficients between prior knowledge of chemistry, physics and mathematics and the program-related course KIN2 are shown. The coefficients close to score 1 are red, indicating a strong positive correlation; those close to score 0 are pink, indicating a weak positive correlation, and the negative coefficients are represented in blue. The subunits during the first and second attempts were indicated as (1) and (2), respectively.

1.3. Correlation between prior knowledge and NIS in 2021-2022 and 2022-2023

During the academic year 2021-2022 for NIS (Figure 4A), the correlation coefficient between the prior knowledge of chemistry and mathematics and NIS is 0.3, while for physics, this correlation is 0.2 at the first attempt. However, in the second attempt, these correlations become negative: the correlation between chemistry and the subunits ranges from -0.1 to -0.2; for physics, the R values shift from 0.1 to -0.1; and for mathematics, the R values range from 0 to -0.1. During the academic year of 2022-2023, there is a coherent, positive correlation between chemistry and mathematics prior knowledge and the NIS subunits, with a value of 0.2 (Figure 4B). The correlation is between 0.1 and 0.2 for physics and the subunits. In contrast to 2021-2022, the second attempt revealed a positive correlation between prior knowledge domains and the subunits. This correlation ranges from 0.1 to 0.2 for physics and mathematics but is notably higher for chemistry, with a correlation coefficient of 0.4.

Figure 4

Correlation between Prior Knowledge Domains and Program-related Course Neurological and Internal Systems for the Academic Year 2021-2022 (A) and 2022-2023 (B).



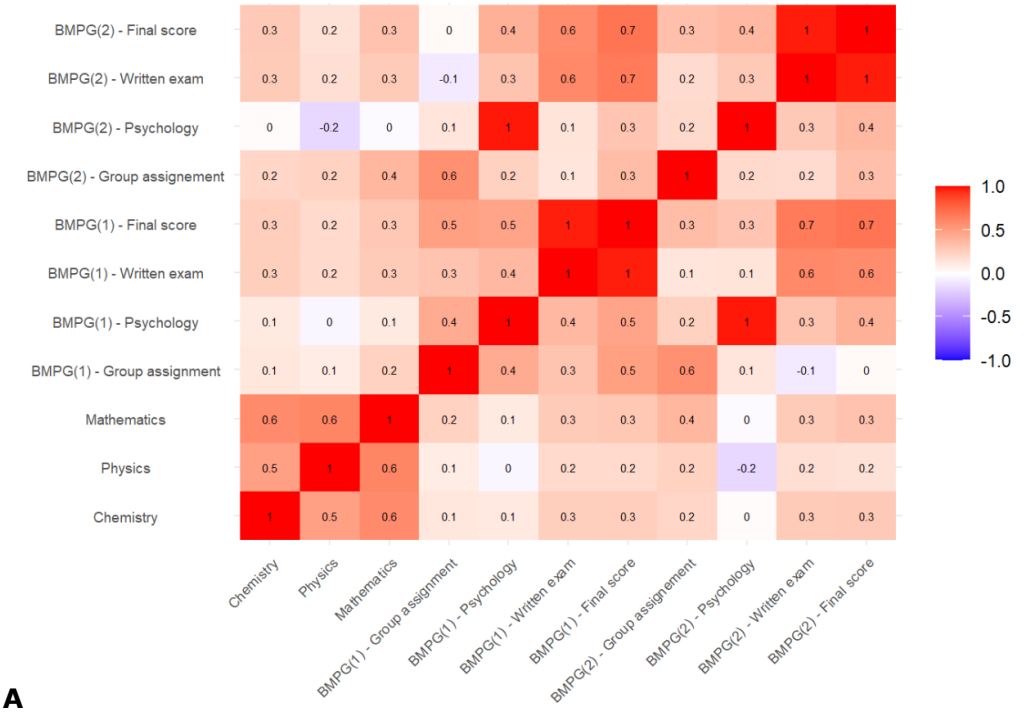
Note. Heatmap of the correlation between prior knowledge domains and the program-related course neurological and internal system (NIS) in the first bachelor year of physiotherapy students for the academic year 2021-2022 (A) and 2022-2023 (B). The correlation coefficients between prior knowledge of chemistry, physics and mathematics and the program-related course NIS are shown. The coefficients close to score 1 are red, indicating a strong positive correlation; those close to score 0 are pink, indicating a weak positive correlation, and the negative coefficients are represented in blue. The subunits during the first and second attempts were indicated as (1) and (2), respectively.

1.4. Correlation between prior knowledge and BMPG in 2021-2022 and 2022-2023

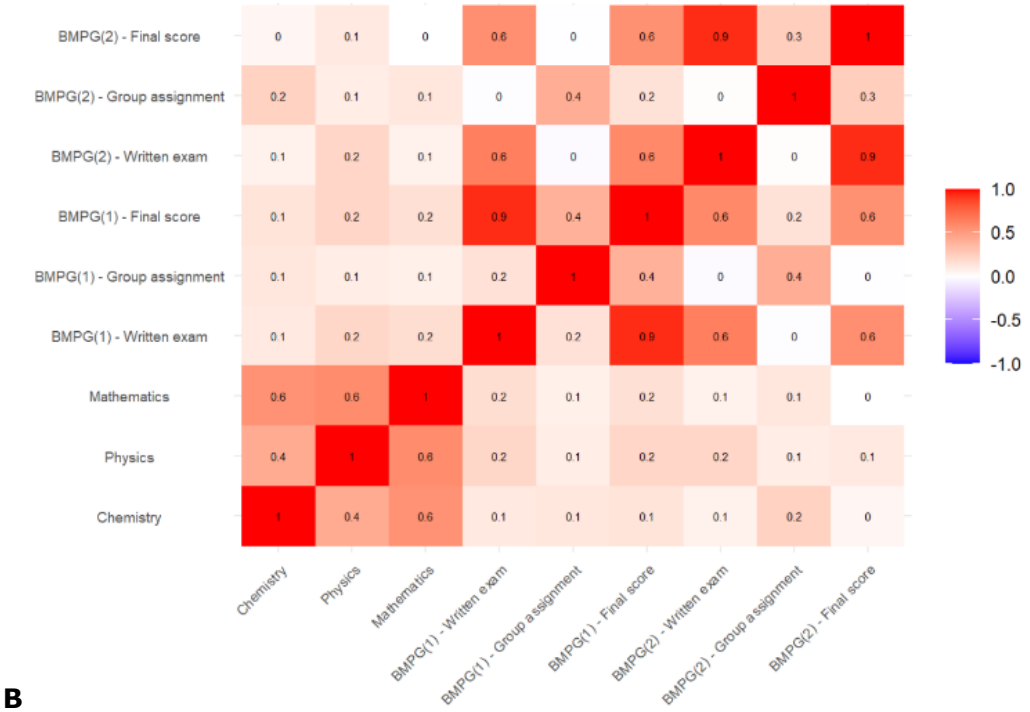
In the first attempt of the 2021-2022 academic year (Figure 5A), the correlation coefficients between chemistry and mathematics and the BMPG subunits range from 0.2 to 0.3. For the prior knowledge of physics, the correlations are between 0.1 and 0.2. In the second attempt, the correlation coefficients vary: the R values range from 0 to 0.3 for chemistry and the subunits of BMPG. Physics shows a broader range, from -0.2 for the group assignment in physiology to 0.2 for the other subunits. For mathematics, the correlations are between 0 and 0.3 for the group assignment in physiology and the writing assignment. In contrast, the correlation with the group assignment in motor control is notably higher, at 0.4. The first attempt of the academic year 2022-2023 results in a correlation coefficient 0.1 between chemistry and the subunits of BMPG (Figure 5B). For physics and mathematics and the subunits, these correlation coefficients range from 0.1 to 0.2. During the second attempt, the correlations range between 0 to 0.2 for chemistry and the subunits, 0.1 and 0.2 for physics and the subunits, and 0 to 0.1 for mathematics and the subunits.

Figure 5

Correlation between Prior Knowledge Domains and Program-related Course Biopsychosocial Model in Paediatrics and Geriatrics for the Academic Tear 2021-2022 (A) and 2022-2023 (B).



A



B

Note. Heatmap of the correlation between prior knowledge domains and the program-related course biopsychosocial model in paediatrics and geriatrics (BMPG) in the first bachelor year of physiotherapy students for the academic year 2021-2022 (A) and 2022-2023 (B). The correlation coefficients between prior knowledge of chemistry, physics and mathematics and the program-related course BMPG are shown. The coefficients close to score 1 are red, indicating a strong positive correlation; those close to score 0 are pink, indicating a weak positive correlation, and the negative coefficients are represented in blue. The subunits during the first and second attempts were indicated as (1) and (2), respectively.

2. The impact of large subunits on academic advancement

Descriptive analyses were conducted utilising datasets from 2021-2022 and 2022-2023 to assess the impact of program-related courses on students' academic progression. Success rates are calculated for the first, second, third and fourth attempts of a particular program-related course and their subunits, in which the number of succeeding students is compared to the number of participating students.

2.1. Kinesiology 1 (KIN1)

For the program-related course KIN1, descriptive analysis revealed that in the academic year 2021-2022, the success rates for the subunit organisational level were 26% for the first attempt exam and 30% for the second attempt exam (Table 1). In the academic year 2022- 2023, these rates were 40% and 18%, respectively. For the practical subunit, the success rates were 36% for the first attempt exam and 58% for the second attempt exam in 2021- 2022, which increased to 65% and 79% in 2022-2023, respectively. Within the academic year 2021-2022, the subunits anatomy and biomechanics were evaluated separately. The success rates in this academic year for anatomy were 48% for the first attempt exam and 75% for the second attempt exam. The success rates for the subunit biomechanics were 23% for the first attempt exam and 43% for the second attempt exam. In the academic year 2022- 2023, these two separate subunits disappeared and were conjoined. The success rates were 50% for the first attempt exam and 34% for the second attempt exam. Subsequent attempts at the exams yielded varying success rates, with the third attempt showing 50% and 58% success rates for the subunit organisational level, within 2021-2022 and 2022-2023, respectively (Table 2). For the practical sessions, the third-chance exam success rates were 75% and 89%, within 2021-2022 and 2022-2023, respectively. In the academic year 2021-2022, the success rate for anatomy and biomechanics were, respectively, 81% and 52% for the third attempt. In the academic year 2022-2023, the conjoined success rate of the latter was 76% for the third attempt. However, for the fourth attempt, success rates were 33% and 53% for the subunit organisational level and 60% and 100% for the subunit practical sessions, within 2021-2022 and 2022-2023, respectively. For anatomy and biomechanics, the success rate were 73% and 40% in the academic year 2021-2022 and 93% in the academic year 2022-2023, although the number of students attempting the fourth time was negligible, rendering these percentages inconclusive.

Table 1

Kinesiology 1's Success and Fail Rates for Subunits during First- and Second-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
First attempt						
Organisational levels	26%	74%	365	40%	60%	258
Anatomy	48%	52%		50%	50%	
Biomechanics	23%	77%				
Practical sessions	36%	64%		65%	44%	
Second attempt						
Organisational levels	30%	70%	171	18%	82%	106
Anatomy	75%	25%		34%	66%	
Biomechanics	43%	66%				
Practical sessions	58%	42%		79%	21%	

Note. Table with success and fail rates (%) for kinesiology 1 subunits (organisational levels, anatomy, biomechanics, practical sessions) during first- and second attempt exams for the academic year 2021-2022 and 2022-2023.

Table 2

Kinesiology 1's Success and Fail Rates for Subunits during Third- and Fourth-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
Third attempt						
Organisational levels	50%	50%	44	58%	42%	38
Anatomy	81%	18%		76%	24%	
Biomechanics	52%	48%				
Practical sessions	75%	25%		89%	11%	
Fourth attempt						
Organisational levels	33%	67%	15	53%	47%	15
Anatomy	73%	27%		93%	7%	
Biomechanics	40%	60%				
Practical sessions	60%	40%		100%	0%	

Note. Table with success and fail rates (%) for kinesiology 1 subunits (organisational levels, anatomy, biomechanics, practical Sessions) for students taking third- and fourth-chance exams for the academic year 2021-2022 and 2022-2023.

Analyses on which subunit, organisational levels, anatomy, biomechanics or practical sessions is most frequently failed by students causing them to retake the entire program-related course, showed a percentage of 14% for the subunit organisational levels versus 1% for anatomy versus 7% for biomechanics versus 1% for practical sessions in the academic year 2021-2022 (Table 3). Within this academic year, 77% of the students failed on more than one subunit within the program-related course KIN1. For the academic year 2022-2023 a percentage of 56% for subunit organisational levels versus 3% for the conjoined subunit anatomy and biomechanics versus 4% for practical sessions was calculated. 37% of these students from the academic year 2022-2023 failed on more than one subunit, causing them to retake this entire program-related course KIN1.

Table 3

Comparative Analysis of Student Scores within Kinesiology 1: Weighted Contribution to taking a Third-Attempt Exam.

	2021-2022		**2022-2023**	
	Second attempt			
	%	***n***	***%***	***n***
Organisational levels	14%	133	56%	68
Anatomy	1%		3%	
Biomechanics	7%			
Practical sessions	1%		4%	
More than one subunit	77%		37%	

Note. Table with percentages (%) about which subunit (organisational levels, anatomy, biomechanics, practical sessions) was most frequently failed within the final score of the program-related course kinesiology 1 (KIN1), determining taking a third-chance exam in academic years 2021-2022 and 2022-2023. The percentages (%) in the first four rows of the table show the proportion of students who failed KIN1 on their second attempt due to failing only one subunit (e.g., organisational levels), resulting in a retake of the entire program-related course KIN1, while passing other subunits (e.g., anatomy, biomechanics, practical sessions). The percentages (%) in the last row represent the proportion of students who failed on multiple subunits on their second attempt, requiring a retake of the entire program-related course KIN1.

2.2. Kinesiology 2 (KIN2)

For the program-related course KIN2, descriptive analyses revealed that in the academic year 2021-2022, the success rates for the subunit practical sessions were 45% for the first attempt exam and 31% for the second attempt exam (Table 4). In the academic year 2022-2023, these rates were 52% and 72%, respectively. In the academic year 2021-2022 the subunits anatomy and biomechanics were evaluated separately. The success rates in this academic year for the subunit anatomy were 53% for the first attempt exam and 36% for the second attempt exam. The success rates for biomechanics were 53% for the first attempt exam and 36% for the second attempt exam. In the academic year 2022-2023, these two separate subunits disappeared and were conjoined into one oral exam. The success rates were 56% for the first attempt exam and 63% for the second attempt exam.

Subsequent attempts at the exams yielded varying success rates, with the third attempt showing 73% and 86% success rates for the practical sessions, within the academic year 2021-2022 and 2022-2023, respectively (Table 5). In the academic year 2021-2022, the success rate for anatomy and biomechanics were, respectively, 77% and 86% for the third attempt. In the academic year 2022-2023, the conjoined success rate of the latter was 100% for the third attempt. However, for the fourth attempt, success rates were 43% and

57% for the practical sessions, within the academic year 2021-2022 and 2022-2023, respectively. For anatomy and biomechanics, the success rates were 43% and 57%,respectively in the academic year 2021-2022 and 100% in the academic year 2022-2023, although the number of students attempting the fourth time was negligible, rendering these percentages inconclusive.

Table 4

Kinesiology 2's Success and Fail Rates for Subunits during First- and Second-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
First attempt						
Practical sessions	45%	54%	209	52%	48%	206
Biomechanics	53%	47%		56%	44%	
Anatomy	53%	47%				
Second attempt						
Practical sessions	31%	69%	110	72%	27%	62
Biomechanics	44.50%	55.55%		63%	37%	
Anatomy	36%	63%				

Note. Table with success and fail rates (%) for kinesiology 2 subunits (practical sessions, anatomy, biomechanics, oral exam) during first- and second attempt exams for the academic year 2021-2022 and 2022-2023.

Table 5

Kinesiology 2's Success and Fail Rates for Subunits during Third- and Fourth-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
Third attempt						
Practical sessions	73%	27%	22	86%	14%	7
Biomechanics	86%	14%		100%	0%	
Anatomy	77%	23%				
Fourth attempt						
Practical sessions	43%	57%	7	100%	0%	1
Biomechanics	57%	43%		100%	0%	
Anatomy	43%	57%				

Note. Table with success and fail rates (%) for kinesiology 2 subunits (practical sessions, anatomy, biomechanics, oral exam) for students taking third- and fourth-chance exams for the academic year 2021-2022 and 2022-2023.

Analyses on which subunit, practical sessions, anatomy, biomechanics, oral exam is most frequently failed by students within the program-related course KIN2 causing them to retake this subunit for a third- and fourth chance exams, showed a percentage of 13% for practical sessions versus 7% for anatomy versus 4% for biomechanics in the academic year 2021-2022. Within this academic year, 76% of the students failed on more than one subunit within the program-related course KIN2, causing them to retake this entire

program-related course. For the academic year 2022-2023 a percentage of 15% for practical sessions versus 37% for the conjoined subunit of anatomy and biomechanics (oral exam) was calculated. 48% of the students from the academic year 2022-2023 failed more than one subunit, causing them to retake this entire program-related course KIN2 (Table 6).

Table 6

Comparative Analysis of Student Scores within Kinesiology 2: Weighted Contribution to taking a Third-Attempt Exam.

	2021-2022		**2022-2023**	
	Second attempt			
	%	***n***	***%***	***n***
Practical sessions	13%	49	15%	27
Biomechanics	4%		37%	
Anatomy	7%			
More than one subunit	76%		48%	

Note. Table with percentages (%) about which subunits (practical sessions, biomechanics, anatomy or oral exam) was most frequently failed within the final score of the program-related course Kinesiology 2 (KIN2), determining taking a third-chance exam in academic years 2021-2022 and 2022-2023. The percentages (%) in the first three rows of the table show the proportion of students who failed KIN2 on their second attempt due to failing only one subunit (e.g., biomechanics), resulting in a retake of the entire program-related course KIN2, while passing other subunits (e.g., anatomy, practical sessions). The percentages (%) in the last row represent the proportion of students who failed on multiple subunits on their second attempt, requiring a retake of the entire program-related course KIN2.

2.3. Neurological and Internal Systems (NIS)

For the program-related course NIS, descriptive analysis revealed that the success rates for the subunit internal system were 49% for the first attempt exam and 68% for the second attempt exam in the academic year 2021-2022. In the academic year 2022-2023, these rates shift to 56% and 52.50%, respectively (Table 7). Similarly, the success rates for the subunit neurological system were 40% for the first attempt exam and 50% for the second attempt exam in 2021-2022, which increased to 59% and 77.50% in 2022-2023, respectively (Table 7). Subsequent attempts at the exams yielded varying success rates, with the third attempt showing 62% and 79% success rates for internal systems, and 57% and 76% for the subunit neurological systems within 2021-2022 and 2022-2023, respectively (Table 8). However, for the fourth attempt, success rates were 0% and 40% for the internal system subunit and 50% and 60% for the neurological system subunit, 2021-2022 and 2022-2023 respectively. Although the number of students attempting the fourth time was negligible, rendering these percentages inconclusive.

Table 7

Neurological and Internal Systems' Success and Failure Rates during the First- and Second-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
First attempt						
Internal systems	49%	51%	177	56%	43%	197
Neurological systems	40%	60%		59%	41%	
Second attempt						
Internal systems	68%	32%	66	52.5%	47.5%	40
Neurological systems	50%	50%		77.5%	22.5%	

Note. Table with success and fail rates (%) for NIS during first and second attempt exams for the academic year 2021-2022 and 2022-2023. NIS, Neurological and Internal Systems.

Table 8

Neurological and Internal Systems' success and Failure Rates during Third- and Fourth-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	***n***	***Passed (%)***	***Failed (%)***	***n***
Third attempt						
Internal systems	62%	38%	21	79%	21%	29
Neurological systems	57%	43%		76%	24%	
Fourth attempt						
Internal systems	0%	100%	2	40%	60%	5
Neurological systems	50%	50%		60%	40%	

Note. Table with success and fail rates (%) for NIS for students taking third- and fourth-chance exams for the academic year 2021-2022 and 2022-2023. NIS, Neurological and Internal Systems.

Analyses on which subunit, neurological systems or internal systems, within the program-related course NIS is most frequently failed by students causing them to retake this program-related course for a third- and fourth chance exams, showed a percentage of 46% for neurological systems versus 16% for internal systems in the academic year 2021-2022 (Table 9). For the academic year 2022-2023 a percentage of 10% for neurological systems versus 57% for internal systems was calculated. Failing on both the subunits was 38% and 33% of the students failed, in 2021-2022 and 2022-2023 respectively, causing them to retake the program-related course NIS completely.

Table 9

Comparative Analyses of Student Scores in Neurological and Internal Systems: Weighted Contribution to taking a Third-Attempt Exam.

	2021-2022		2022-2023	
	Second attempt			
	%	*n*	*%*	*n*
Internal systems	16%	39	57%	21
Neurological systems	46%		10%	
Both subunits	38%		33%	

Note. Table with percentages (%) about which subunit (internal or neurological systems) was most frequently failed within the final score of the program-related course NIS, determining taking a third-chance exam in academic years 2021-2022 and 2022-2023. The percentages (%) in the first two rows of the table show the proportion of students who failed NIS on their second attempt due to failing only one subunit (e.g., Internal systems), resulting in a retake of the entire program-related course NIS, while passing the other subunit (e.g., Neurological systems). The percentages (%) in the last row represent the proportion of students who failed on multiple subunits on their second attempt, requiring a retake of the entire program-related course NIS.

2.4. Biopsychosocial Model in Paediatrics and Geriatrics (BMPG)

For the program-related course BMPG, descriptive analysis revealed that in the academic year 2021-2022, the success rates for the written exams were 41% for the first attempt exam and 36% for the second attempt exam (Table 10). In the academic year 2022-2023, these rates were 37% and 46%, respectively. In the academic year 2021-2022, the success rates of the two group assignments (motor and psychological part) were 69% and 92%, respectively, for the first attempt exam and 90% and 98% for the second attempt exam. In the academic year 2022-2023, the success rates of the group assignment (motor and psychological parts conjoined) were 70% for the first attempt exam and 95% for the second attempt exam. Subsequent attempts at the exams yielded varying success rates, with the third attempt showing 33% and 43% success rates for the written exam, within the academic year 2021-2022 and 2021-2023, respectively. In the academic year 2021-2022, the success rate for the two group assignments (motor and psychological) were, respectively, 93% and 40% for the third attempt. In the academic year 2022-2023, the conjoined success rate of the latter was 78% for the third attempt. However, for the fourth attempt, success rates were 67% and 38% for the written exam, 2021-2022 and 2021-2023, respectively (Table 11). For the two groups assignments (motor and psychological part), the success rates were 67% and 33%, respectively in the academic year 2021-2022 and 100% in the academic year 2022-2023. However, the number of students attempting the fourth time was negligible, rendering these percentages inconclusive.

Table 10

Success and Fail Rates for Biopsychosocial Model in Paediatrics and Geriatrics (BMPG) Subunits during First- and Second-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	**n**	**Passed (%)**	**Failed (%)**	**n**
First attempt						
Written exam	41%	59%	181	37%	63%	188
Group assignment motor	69%	31%		70%	30%	
Group assignment psychology	92%	8%				
Second attempt						
Written exam	36%	64%	80	47%	53%	97
Group assignment motor	90%	10%		96%	4%	
Group assignment psychology	98%	2%				

Note. Table with success and fail rates (%) for biopsychosocial model in paediatrics and geriatrics (BMPG) subunits (written exam, and groups assignments) during first- and second attempt exams for the academic year 2021-2022 and 2022-2023.

Table 11

Success and Fail Rates for Biopsychosocial Model in Paediatrics and Geriatrics (BMPG) Subunits during Third- and Fourth-Attempt Exams.

	2021-2022			2022-2023		
	Passed (%)	***Failed (%)***	**n**	**Passed (%)**	**Failed (%)**	**n**
First attempt						
	33%	67%	15	43%	57%	23
Group assignment motor	93%	7%		78%	22%	
Group assignment psychology	40%	60%				
Second attempt						
Written exam	67%	33%	9	39%	61%	13
Group assignment motor	67%	33%		100%	0%	
Group assignment psychology	33%	22%				

Note. Table with success and fail rates (%) for biopsychosocial model in paediatrics and geriatrics (BMPG) subunits (written exam and the motor and psychological group assignments) for students taking third- and fourth-chance exams for the academic year 2021-2022 and 2022-2023.

Analyses on which subunit, namely written exam, motor group assignment, psychological group assignment, within the program-related course BMPG is most frequently failed by students causing them to retake this program-related course for third- and fourth chance exams, showed a percentage of 83% for the written exam versus 2% for the motor group assignment versus 0% for the psychological group assignment in the academic year 2021-2022 (Table 12). Within this academic year, 15% of the students failed on more than one subunit within the program-related course BMPG, causing them to retake this entire program-related course. For the academic year 2022-2023 a percentage of 92% for the written exam versus 2% for the group assignment was calculated. 6% of these students from the academic year 2022-2023 failed on more than one subunit, causing them to retake the entire program-related course BMPG during the next academic year.

Table 12

Comparative Analysis of Student Scores within Biopsychosocial Model in Paediatrics and Geriatrics (BMPG): Weighted Contribution to taking a Third-Attempt Exam.

	2021-2022		**2022-2023**	
	Second attempt			
	%	***n***	***%***	***n***
Written exam	83%	52	92%	53
Group assignment motor	2%		2%	
Group assignment psychology	0%			
More than one subunit	15%		6%	

Note. Table with percentages (%) about what subunits (written exam, motor group assignment, psychological group assignment) was most frequently failed within the final score of the program-related course biopsychosocial model in paediatrics and geriatrics (BMPG), determining taking a third-chance exam in academic years 2021-2022 and 2022-2023. The percentages (%) in the first three rows of the table show the proportion of students who failed BMPG on their second attempt due to failing only one subunit (e.g., Group assignment motor), resulting in a retake of the entire program-related course BMPG, while passing other subunits (e.g., written exam). The percentages (%) in the last row represent the proportion of students who failed on multiple subunits on their second attempt, requiring a retake of the entire program-related course BMPG.

DISCUSSION

The dropout rate for first-year tertiary education students is rising, which attracts the attention of stakeholders and educational institutions. However, less is known about the impact of prior knowledge and large program-related courses on the students' progression in PRS, and therefore, research is needed. This study aims to investigate two important factors that may influence the dropout rate. First, it explores the relationship between prior knowledge assessments in mathematics, biology, and chemistry and first-year students' academic achievement in the PRS-program. Second, it seeks to discern how failing specific subunits affects students' academic progression.

1. The correlation between prior knowledge and exam performance

Various statistical analyses were conducted to study the influence of prior knowledge on students' performance in tertiary education. Visualised in heatmaps, correlation coefficients ranged from weak to moderately positive, specifically between 0.1 and 0.5. Most subunits exhibited poor positive correlations, with coefficients between 0 and 0.3. Consequently, we focused on discussing courses where the correlation coefficients with

prior knowledge domains were stronger, specifically between 0.4 and 0.5.
Within the academic year 2021-2022, the highest observed correlation value of 0.5 was discriminated between the prior knowledge domain mathematics and the subunit biomechanics of KIN1 after the first attempt. Besides, positive correlations of 0.4 were reported for KIN1 between physics and biomechanics, mathematics and organisational levels, and between the prior knowledge domains physics, mathematics, and the overall total score of KIN1 in the first attempt. A positive correlation of 0.3 was also reported between mathematics and the biomechanics subunit of the program-related course KIN2. In the second attempt, only mathematics was positively correlated by 0.4 with the biomechanical subunit of KIN2 and the group assignment of BMPG.
Additionally, within the academic year 2022-2023, no correlation coefficient of 0.5 was reported, and only a few subunits surpassed the correlation coefficient threshold of 0.4. Specifically, the prior knowledge domain of chemistry positively correlated with both the internal and neurological systems subunits of NIS, highlighting the influence on students' performance in these areas.
Despite the absence of an overall strong correlation between prior knowledge and program-related courses, minor positive correlations suggest a plausible relationship between specific prior knowledge domains and certain program-related courses. This is significant because not all program-related courses, such as the practical sessions and anatomy within KIN1 and KIN2, rely on these prior knowledge domains.

1.1. Prior knowledge in mathematics

In contrast, the correlation coefficients between mathematics and the biomechanics subunits of KIN1 and KIN2 were notably apparent in the first and second attempts during the academic year 2021-2022. According to the course guide for KIN1 and KIN2 in the PRS program, the biomechanics subunit covers the biomechanical movement features of the human body, which require goniometric mathematical concepts (Informatie Opleidingsonderdeel, n.d.).
These results may indicate that a solid foundation in mathematics is essential for understanding and studying the new concepts presented in the KIN1 and KIN2 subunits. This finding aligns with Cabuqion et al. (2023), who reported a highly positive correlation between secondary students' mathematics performance and their academic achievement for both male and female students. This study noted that students with weaker backgrounds in mathematics tend to struggle and fail in their academic courses. Since the mathematical performance was positive highly correlated with academic success in this study, these results differ from the mild positive correlations of the heatmaps. This difference in correlation strength, might be the result of differences in data retrieval. Cabuqion et al. analysed the data of secondary students, while our study investigated the results of prior knowledge tests of the PRS programme. This might suggest that prior knowledge tests of PRS should be further refined.
Prior knowledge in mathematics frequently correlates strongly with other program-related courses, underscoring its crucial role in specific domains such as biomechanics and organisational levels within kinesiology-related courses. This foundational mathematical knowledge is essential for students, as it enhances their ability to interpret complex data sets and develop robust hypotheses, as Hailikari et al. (2008) and Rach & Ufer (2020) noted. Proficiency in mathematics equips students with the analytical skills necessary for conducting rigorous experiments and research, thereby facilitating their academic success and competency in practical applications within the field of kinesiology.

1.2. Prior knowledge in physics

Additionally, prior knowledge of physics is crucial for success in KIN1, which showed a positive correlation with biomechanics and the overall score of KIN1 on the first attempt in 2021-2022. According to the study guide, physics is important in the biomechanics subunit because it builds on fundamental principles of kinematics and kinetics, loads, and acting forces (Informatie Opleidingsonderdeel, n.d.). However, fewer studies specifically examine the relationship between prior knowledge of physics and academic success. Nevertheless, the interconnectedness between mathematics and physics is well-documented (Jihe et al., 2021).
Jihe et al. (2021) discussed that mathematics and physics are closely related foundational subjects, with physics relying heavily on mathematical argumentation and reasoning. This conclusion was drawn from the performance results of mathematics and physics tests among senior high school students. Further, Tawari et al. (2013) confirmed that students' performance in integrated science courses, such as general physics, is dependent on their prior knowledge of mathematics.
These findings align with the results of the heatmaps, which show that prior knowledge in mathematics and physics positively correlates with other program-related courses due to their intrinsic relationship. This underscores the importance of a strong foundation in both subjects for academic success in related courses. According to the study results, no positive correlation has been found for physics without a positive correlation between the prior knowledge of mathematics and a program-related course.

1.3. Prior knowledge in chemistry

For the academic year 2022-2023, the prior knowledge domain chemistry demonstrated a positive correlation coefficient of 0.4 with internal and neurological systems of NIS. This was in line with the conclusions of Seery (2009), who examined the strong correlation between the impact of prior chemistry knowledge on the first bachelor year chemistry performance. This strong correlation was only demonstrated during the second exam attempt. The correlation coefficients were only 0.2 for the first exam attempt, indicating a weak to moderate correlation between prior chemistry knowledge and the chemistry exam performance.

1.4. Negative correlations

In contrast, the NIS data unveiled a consistent pattern of low negative correlation coefficients, hovering around -0.1, across most prior knowledge domains during the second attempt in the academic year 2021-2022. This concurrence with the guidelines outlined in the study guide seems rational, as the guide explicitly stipulates a requirement for prior knowledge limited to biology, albeit this subject was not formally evaluated in the prior knowledge examination (Informatie Opleidingsonderdeel, n.d.). The omission of a biology knowledge assessment potentially represents a missed opportunity for valuable insights. However, a comprehensive investigation into these NIS correlations is imperative, particularly given their consistent negativity throughout the second attempt. This suggests the influence of multiple factors, including fewer students at the second attempt, heightened levels of difficulty (Lynch et al., 2013), decreased motivation, or readiness-related challenges (Grabe, 1994). A comparable trend is evident in the group assignment for psychology within the BMPG (Biomedical Sciences and Pharmaceutical Sciences) course during the second attempt.

1.5. Summarisation

While not all correlations can be fully elucidated, they denote significant correlations between these specific knowledge domains and subunits, highlighting the interconnectedness of foundational principles across diverse disciplinary boundaries within the educational framework. Though a clear relationship exists between specific prior knowledge domains and some subunits, the overall modest to minimal correlation coefficients imply that multiple factors have their influence. Sarder et al. (2022) elucidated that pedagogical methodologies significantly impact the academic performance of university students. They emphasised the efficacy of teaching practices enriched with feedback mechanisms, dynamic in-class discussions, transparent course design, and the integration of contemporary teaching tools. Additionally, the pivotal role of secondary education in furnishing students with essential skills and knowledge cannot be overstated, as underscored by Eriksson et al. (2018), Morgan et al. (2018), and Osman (2022). Furthermore, as previously discussed, several other factors likely exert influence on student performance. These encompass individual student attributes such as varying levels of interest (Deslauriers et al., 2019), intrinsic motivation, and readiness (Grabe, 1994).

To summarise, a plausible correlation exists between prior knowledge domains and program-related courses and their subunits with a coefficient of 0.1-0.3. However, for the first and second attempts, a stronger correlation exists between mathematics and biomechanics of kinesiology-related courses in the academic year 2021-2022. Also, a noteworthy correlation between physics and KIN1 was reported. This may demonstrate that vast prior knowledge of mathematics and physics influences the student's academic performance in the PRS-program. This indication can be used by stakeholders and educational institutions to inform new starting students and attract the right educational profile. Furthermore, educational institutions can adjust their curriculum to the prior knowledge taught in secondary schools or even provide summer mathematics and physics courses to reach the desired level of prior knowledge before initiating the PRS-program.

2. The impact of large subunits on academic advancement

A descriptive analysis investigated how failing specific subunits affects students' academic advancement. An investigation was conducted into the curricula of the PRS program for the academic years 2021-2022 and 2022-2023 to assess whether the inclusion of large program-related courses impedes student progression. Within this curriculum framework, students are allowed to retake exams for smaller subunits they failed, up to a maximum of two attempts. Subsequently, if unsuccessful after the second attempt, students are required to retake the entire program-related course encompassing the failed subunit. This entails a second complete iteration of the large program-related course, affording students a third chance to pass the previously failed small subunit, and if necessary, a fourth attempt, all within the academic framework of the University of Hasselt. Following four unsuccessful attempts, students face exclusion from further academic progression. Nonetheless, students are compelled to retake entire large program-related courses rather than exclusively focusing on repeatedly retaking the specific smaller subunits in which they failed. Up until now, it is unclear whether this system hinders the student's progression. Therefore, a meticulous descriptive analysis was executed to study the percentages of passed and failed students for each subunit for the first and second attempts and the third and fourth attempts.

The academic years 2021-2022 and 2022-2023 differ due to modification of the composition of some large subunits, which should be kept in mind during the analyses. In

the academic year 2021-2022, the structure of KIN1 encompassed four distinct smaller subunits delving into organisational levels, anatomy, biomechanics, and practical sessions. However, in 2022-2023, KIN1 was modified into three smaller subunits, combining anatomy and biomechanics into one unified oral exam. Similarly, in KIN2, anatomy and biomechanics were converted into one oral examination component. For BMPG, the curriculum changed from two group assignments to one more comprehensive group assignment. In contrast, the small subunits of the large program-related course NIS were identical in both years.
The meticulous descriptive analysis was performed for KIN1, KIN2, NIS and BMPG during the academic years 2021-2022 and 2022-2023.

2.1. Kinesiology 1 (KIN1)

During the academic year 2021-2022, at their first attempt, many students faced challenges in the subunits biomechanics and organisational levels of KIN1, in which 77% and 74%, respectively, failed. This consists of a substantial portion of the total student population enrolled in the program-related course KIN1, indicating the magnitude of difficulty of these subunits. However, 66% and 70% failed again at the second attempt. Remarkably, among those students who failed to pass these subunits after the second attempt, 14% were mandated to retake the entire program-related course KIN1 in the subsequent academic year solely due to their failure at organisational levels. In comparison, 7% encountered a similar fate owing to their inability to succeed in biomechanics despite achieving success in all other smaller subunits within KIN1. Furthermore, it is noteworthy that a significant majority, constituting 77% of these students, encountered difficulties across multiple smaller subunits during their second attempt, mandating them to retake the entire program-related course KIN1.
During the academic year 2022-2023, restructuring the program-related course KIN1 presented a distinctive challenge for comparative analyses with the preceding academic year. Despite this transition, the previous pattern reoccurred. Once again, organisational levels emerged as an obstacle, with 60% of students encountering difficulty during their first attempt. This persisted during the second attempt, with 82% of students. Further analyses of the data revealed that among students who failed their retake examinations for KIN1, a substantial proportion, accounting for 56%, faced the prospect of retaking the entire program-related course KIN1 during the next academic year due to their inability to pass the organisational levels subunit.
In the academic year 2021-2022, a substantial portion of students, representing 67% and 60%, respectively, failed their fourth attempt primarily due to struggles in the organisational levels and biomechanics subunits. This trend persisted into the academic year 2022-2023, with 47% of students undergoing a fourth attempt still encountering difficulty in organisational levels, ultimately eliminating them from the PRS.
These results indicate the disproportional impact of the small subunits organisational levels and biomechanics in the program-related course KIN1 on students' academic progression and emphasise the critical necessity for targeted support and remediation efforts in this domain. Moreover, many students who took the fourth exam failed, leading to exclusion from the program, suggesting the potential benefit of restructuring the individual subunits within KIN1 to mitigate the risk of organisational levels and biomechanics, precipitating overall failure in the program-related course KIN1 for students. Also, this might indicate a systemic issue necessitating comprehensive intervention strategies to improve students' success.

2.2. Kinesiology 2 (KIN2)

Identifying a singular small subunit as the reason for retaking an entire program-related course formed a challenge within the framework of KIN2.

Throughout the academic year 2021-2022, failure rates for the small subunits 'anatomy' and 'biomechanics' were elevated, standing at 47%, while' practical sessions' exhibited an even higher failure rate of 54% during the first attempt. During the second attempt, 69%, 63% and 55% of students undergoing re-examination failed to meet the requisite standards in practical sessions, anatomy and biomechanics, respectively. Significantly, among students necessitated to retake the exam, 13% were compelled to retake the entire program-related course KIN2 the subsequent academic year solely due to their struggle with the small subunit practical sessions. Furthermore, a significant majority of these students, comprising 76%, grappled with difficulties across multiple subunits within the program-related course KIN2, thereby necessitating the comprehensive undertaking of the entire program-related course in the subsequent academic year.

In the academic year 2022-2023, the subunits anatomy and biomechanics were unified in an oral exam. Nevertheless, despite this structural adjustment, discernible trends emerged in student performance within the large program-related course KIN2. During the first attempt, 48% of students encountered difficulty in practical sessions, a notable proportion of students encountered challenges, with 48% struggling in practical sessions and 44% failing the oral examination. Nonetheless, an improvement was observed during the subsequent attempt, with a reduction in failure rates, as only 27% of students failed practical sessions and 37% failed the oral examination. Despite this improvement, a significant subset of students continued to fail during their second attempt. Among students who continued to face challenges during their second attempt, 37% were required to retake the entire program-related course KIN2 in the next academic year solely due to their struggle with the oral examination. Additionally, 15% were compelled to retake the entire program-related course KIN2 in the subsequent year because they failed 'practical sessions'.

During the academic year 2021-2022, 43-57% of students grappled with challenges across all three smaller subunits during their fourth attempt, reflecting a pervasive struggle and the potential for comprehensive intervention and support initiatives. Contrastingly, in the subsequent academic year 2022-2023, a notable transformation occurred, with none of the students encountering failure in either subunit during their fourth attempt, underscoring a marked improvement in academic outcomes and highlighting the efficacy of targeted intervention efforts implemented within the PRS-program.

In summary, identifying one subunit as the sole reason for retaking the program-related course KIN2 was challenging. The failure rates were high across the subunits anatomy, biomechanics, and practical sessions, with practical sessions having the highest failure rate. During subsequent attempts, practical sessions remained a challenge. In contrast to the academic year 2021-2022, wherein practical sessions posed the most significant challenge for students, there has been a notable shift towards the oral examination presenting a hurdle in 2022-2023. This transition may be attributed to unifying anatomy and biomechanics into a singular oral examination-format. Subdividing the oral examination into two distinct subunits, anatomy and biomechanics, can possibly be beneficial in providing a proper solution.

2.3. Neurological and Internal Systems (NIS)

Within the program-related course NIS, inconclusive results were observed throughout the academic years.

In the academic year 2021-2022, at the first attempt, 51% and 60% of the students failed the subunits neurological systems and internal systems, respectively. Upon the second attempt, 50% of students faced difficulty in neurological systems, yet the rate decreased to 32% for internal systems. Among those who struggled during their second attempt, 46% were obligated to retake the entire program-related course NIS in the subsequent academic year solely due to their difficulty in the subunit neurological systems.
Conversely, the trend was reversed in the academic year 2022-2023. During the first attempt, 43% of students failed internal systems, while 41% failed neurological systems. Upon the second attempt, a significant proportion, 47.5%, continued to struggle with internal systems, whereas only 22.5% persisted in experiencing challenges with neurological systems. Among those who continued to face difficulty during their second attempt, 57% had to retake the program-related course NIS in the subsequent academic year due to their struggles with the subunit internal systems.
This inconsistency in results could be attributed to differences in course instructors (Özgüngör, 2013) or potential discrepancies in the difficulty level of the examination (Lynch et al., 2013).
During the academic year 2021-2022, all students retaking the subunit internal systems for the fourth time failed and subsequently had to dropout of the PRS-program. Similarly, for the subunit neurological systems, 50% of students failed and faced the same consequence. In contrast, during the academic year 2022-2023, 60% of students failed the internal systems exam, leading to their dropout from the PRS-program. Meanwhile, 40% failed the neurological systems exam, meeting the same fate. However, it's essential to interpret these results cautiously due to the limited number of students who underwent a fourth attempt exam.
In summary, the investigation of the subunit NIS across the academic years yielded inconclusive findings, complicating the identification of a singular subunit as the primary culprit for student difficulties. Notably, during the academic year 2021-2022, elevated failure rates were evident in both the neurological systems and internal systems subunits. The highest proportion of failures was attributed to neurological systems, enabling students to retake the entire program-related course NIS. However, this pattern shifted in the subsequent academic year, while both failure rates remained elevated, internal systems emerged as the primary factor contributing to student dropout from the PRS program.

2.4. Biopsychosocial Model in Paediatrics and Geriatrics (BMPG)

In the case of the program-related course BMPG, despite integrating the two group assignments into one big group assignment over the academic years, the outcome remained consistent.
In the academic year 2021-2022, most students struggled with the written exam, followed by the motor group assignment and the psychological group assignment, with 59%, 31%, and 8% of students failing these subunits, respectively. Despite improvements in the group assignments during the second attempt, most students failed the written exam again, totalling 64%. Consequently, of the students failing their second attempt, 83% of these students were required to retake the program-related course BMPG solely due to their struggle with the subunit written exam.
Similarly, in the academic year 2022-2023, the pattern persisted, with 63% failing the written exam and only 30% failing the group assignment during the first attempt. Once more, during the second attempt, a significant proportion of 53% failed the written exam, while only 4% failed the group assignment. Subsequently, among those failing on their

second attempt, 92% were mandated to retake the entire program-related course BMPG during the next academic year solely due to their struggle with the written exam.
Among the students undertaking a fourth attempt exam in 2021-2022, 22-33% faced dropout solely due to failure in the written exam or one of the group assignments. This means that a singular subunit is absent as the exclusive cause of dropout. Conversely, in 2022-2023, students attempting the fourth attempt exclusively failed the written exam for the fourth time, establishing it as the primary cause for dropout from the PRS-program.
In summary, the primary challenge within the program-related course BMPG is the written exam. It would be valuable to delve into this subunit and examine the underlying factors contributing to any shortcomings.

3. Limitations

3.1. Regarding the data

Since some students were absent for one or more subunits, these data points were indicated as absent or not following, with a resulting fail as the final score. No numerical data was present for these students, leading to data loss. Furthermore, for the students who had received a fail due to not succeeding subunits, the fail was calculated as a numeric value according to the partial weights of their subunits. This data was essential for the analyses; therefore, the compensation rule of the physiotherapy and rehabilitation sciences program was abandoned. For a follow-up study, there should be enough attention to possible underlying factors and comparison of datasets that include the same courses and, therefore, fitting data as well as possible. This would make the interpretation and conclusions more straightforward. It would also be noteworthy to screen for correlations between the program subunits.
Furthermore, the data of the prior knowledge domains is discussable. Since the prior knowledge data is extracted from prior knowledge exams of which the results were not bound to the outcome, the student is not expelled from the PRS-program if they failed the exams. Consequently, it is plausible to assume that not all students approached these exams with utmost seriousness and exerted maximal effort to achieve success.

3.2. Regarding curricular changes

Although the correlation coefficients between prior knowledge and program-related courses in the heat maps indicate minimal to modest correlations, the interpretation should be performed rigorously. Firstly, the correlation coefficients between the different courses were not always representative between the academic years. The program-related course KIN1 consisted, in the academic year 2021-2022, of separate subunits such as anatomy and biomechanics, while in 2022-2023, these subunits were combined into one single oral examination. The program-related course KIN2 consisted of three subunits, i.e. practical sessions, biomechanics and anatomy, and only two subunits, oral examination and practical sessions, in the academic years 2021-2022 and 2022-2023, respectively. Also, the program-related course BMPG' differentiates between the two academic years in group assignments. Since the composition of the program-related course NIS was consistent, a proper conclusion can be drawn from NIS between the academic years without considering any curricular changes.
However, even program-related courses that retained the same structure across both academic years exhibited outcome variations, suggesting contributing additional cofactors. These possible factors became apparent during the analyses of the impact of large subunits on academic progression between the academic years 2021-2022 and 2022-2023 and

their inconsistencies. These inconsistencies could be explained by several factors. For example, exams have not been equally challenging across the years, impacting the students' achievement and progression (Lynch et al., 2013). Also, changes in teaching staff or differences in pedagogical approaches may have had an influence (Sarder et al., 2022), leading to varying success rates between academic years. Since these underlying factors have an unmistakable impact on the study achievement of students, they need to be investigated more thoroughly in follow-up studies.

3.3. Regarding student cohort

The inconsistency in the correlation coefficients can possibly also result from the difference of students concern in the first and second attempts. In the second attempt, the student population consists of those who already failed the first attempt. As previously mentioned, this creates a skewed sample since the students who passed the first attempt, with higher scores on the prior knowledge tests and other subunits, are not included in the second attempt. Consequently, this might explain why the correlation coefficients between the first and second attempts were inconsistent.

3.4. Impact of covid-19

The impact of the Covid-19 pandemic on tertiary education during 2020, up until 2022 was profound, particularly for students in the academic years 2021-2022 and 2022-2023. These students experienced a "covid-proof" academic program, characterised by exclusively online courses and restricted practical sessions. This unprecedented shift in the educational environment, although necessary at the time, has led to results that may not be entirely representative of traditional educational settings.

Acheampong (2023) conducted a study highlighting how the COVID-19 lockdown significantly influenced student academic success and achievement. Key contributing factors included a loss of interest in studies, lack of accessible internet, unavailability of learning devices, reduced interaction, and feelings of loneliness. These findings align with other research, such as studies by Owusu-Fordjour et al. (2020) and Tamrat (2021), which also reported similar adverse effects on student learning and engagement. Moreover, a comprehensive review by Di Pietro (2023) emphasises that the detrimental effects of Covid-19 on education are long-lasting and necessitate urgent and coordinated efforts to address the resulting learning deficits. Among the recommended strategies are the promotion of metacognition skills, as suggested by Stanton et al. (2021), and fostering student collaboration and dialogue. These approaches can significantly enhance learning outcomes by encouraging students to think critically about their learning processes and engage more deeply with their peers.

Despite the predominantly negative impacts highlighted by many studies, it is also crucial to recognize some positive outcomes of the pandemic on education. A study by Said (2021) found that the pandemic led to improvements in students' digital skills and the adoption of innovative pedagogies, which positively affected student achievement. These findings are corroborated by Limniou et al. (2021), who also reported enhanced digital competencies and creative teaching methods as beneficial outcomes of the pandemic-induced shift to online learning.

In summary, while the Covid-19 pandemic posed significant challenges to student achievement due to various disruptions and a shift to remote learning, it also spurred advancements in digital skills and pedagogical innovations. Addressing the long-term learning deficits will require a balanced approach that incorporates both the lessons learned and the positive changes brought about during this period. It is important to keep

this in mind while interpreting the results as this might cause the results to be less representative for educational settings nowadays.

4. Future research

For future research, it is essential to expand the scope of prior knowledge domains to include subjects such as biology, and to conduct a comprehensive analysis of the entire curriculum. In this study, our focus was limited to the specific program-related courses KIN1, KIN2, NIS, and BMPG, all of which are integral to the PRS program. However, extending the investigation to additional program-related courses would provide a more holistic understanding of student progression and the factors influencing academic success.

Additionally, it would be valuable to examine the impact of socio-economic and ethnic backgrounds on prior knowledge and academic outcomes. Correlating these factors with prior knowledge assessments could illuminate the complex dynamics at play and reveal the potential consequences of the current academic protocol on student progression within the PRS program. This approach would help identify any underlying disparities and inform strategies to support a diverse student body more effectively.

By incorporating these elements into future studies, we can gain deeper insights into the multifaceted influences on student achievement and develop targeted interventions to enhance educational outcomes in the PRS program.

While interpreting the results of this study, it is crucial to consider its limitations. Further research is necessary to draw more definitive conclusions.

CONCLUSION

The study comprises two primary research components. Firstly, it investigates the influence of prior knowledge on the performance and progression of students in the 'Physiotherapy and Rehabilitation Studies' (PRS) curriculum at the University of Hasselt in tertiary education. The findings indicate that prior knowledge in ‘mathematics’ and ‘physics’ is crucial for passing smaller subunits, particularly in subunits such as ‘biomechanics’ within kinesiology-related courses.

Secondly, the study examines the impact of the weight of specific smaller subunits on student progression and potential exclusion from the program. For the program-related course KIN1, the organisational levels and biomechanics disproportionately affected student progression. In the course program-related course KIN2, no single subunit stood out, as high failure rates were observed across all subunits. For the program-related course NIS, the two smaller subunits were equally weighted in terms of their impact on passing. Within the program-related course BMPG, the main difficulty was identified in the written examination.

These results provide valuable insights into the importance of prior knowledge and the challenges associated with specific program-related courses in the PRS program. They highlight the necessity of addressing these academic hurdles to improve student outcomes and progression within the program.

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CREATIVE PRODUCT

Below, the creative product which consists of a flyer underscoring our main results, conclusions and recommendations for the physiotherapy and rehabilitation sciences educational program at the University of Hasselt. This platform has been chosen to mainly inform educational institutions and their stakeholders and suggest changes in the current curriculum to minimise the number of dropouts of first-year students.