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Academic Engagement and Basic Psychological Needs: A Systematic Review of Research Trends in Self-Determination Theory

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Abstract: This study is grounded in self-determination theory (SDT) and employed bibliometric analysis to systematically review 439 peer-reviewed articles that report on studies of basic psychological needs and academic engagement in the education field. The findings reveal a stable and widely adopted model centered around the following pathway: need satisfaction → motivational activation → engagement behavior. The variable structure has become increasingly refined, and the application of SDT has expanded into diverse education contexts. Methodologically, most studies use quantitative, cross-sectional designs, while longitudinal and mixed-method approaches remain underrepresented. The research focus has been predominantly on university and secondary school students, with limited attention given to vocational learners and other non-traditional learner groups. International collaboration is shifting toward multi-centered development, with emerging contributors, such as China, demonstrating growing academic influence and increasing localization efforts. This review confirms strong theoretical adaptability of SDT in education, which emphasizes the need for future research to enhance model integration, diversify methodologies, and deepen cross-cultural comparisons. Such steps will foster closer interaction between theory and practice, thereby ultimately enriching educational strategies and improving academic engagement.

Keywords: self-determination theory; basic psychological needs; academic engagement; bibliometric analysis; motivation

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1. Introduction

1.1 Research Background

Improving the quality of higher education is a central focus of global education reform (Meng & Zhang, 2023). In this context, academic engagement, a key indicator of education quality (Wang et al., 2022), has gained increasing attention in recent years (Skinner et al., 2008). Academic engagement is generally understood as referring to a sustained emotional and cognitive state that reflects students' psychological fulfillment in learning, rather than a temporary response (Chen et al., 2021). Higher levels of academic engagement contribute to improved academic performance (Aubrey et al., 2022), and to reduced dropout rates and higher graduation rates (Marôco et al., 2020).

Self-determination theory (SDT) has been particularly influential in explaining student engagement. According to SDT, individuals are inherently driven by three basic psychological needs: competence, autonomy, and relatedness (Deci & Ryan, 1985, 2004). Satisfying these needs fosters intrinsic motivation, supports psychological well-being, and optimizes functioning (Deci & Ryan, 2004). SDT distinguishes between intrinsic and extrinsic motivation, with the latter categorized by varying levels of internalization (Ryan & Deci, 2000a). In education, extrinsic motivation is not necessarily detrimental; when external goals are internalized, they can drive learning in a powerful way (Dev, 1997). The degree of internalization is related to the autonomy of motivation, which directly influences the quality and sustainability of academic engagement (Karimi & Sotoodeh, 2020).

While frameworks such as expectancy-value theory and goal-orientation theory focus on achievement motivation, SDT stands out by emphasizing the ongoing satisfaction of psychological needs. Unlike expectancy-value theory, which centers on outcome expectations, and goal-orientation theory, which focuses on performance goals, SDT asserts that autonomy, competence, and relatedness drive intrinsic motivation, which provides a direct explanation for the quality and persistence of engagement, and makes SDT ideal for understanding sustained engagement in higher education reform.

1.2 Research Objectives

Although SDT has been studied widely, no bibliometric study has yet examined its relationship with academic engagement. This gap limits our understanding of how SDT contributes to academic engagement research. To address this gap, our study conducted a systematic bibliometric review of literature on the relationship between basic psychological needs and academic engagement. By using bibliometric analysis, we trace the evolution of research, identify key knowledge structures, and evaluate their theoretical and practical implications. The main goal was to synthesize findings, identify research gaps, and propose directions for future theoretical development and practical applications. This will provide a clearer theoretical framework for researchers and guide strategies to improve academic engagement in education settings.

The specific research questions guiding this study are:

1. What are the current research hotspots under the themes of basic psychological needs and student academic engagement? This includes high-frequency keywords, key scholars, and core countries.
2. How have the research trends in this field evolved? This includes the evolution of research focus, research pathways, research methods, and research subjects.
3. What are future research directions in terms of theoretical expansion, methodological innovation, and practical application?

2. Theoretical Background

2.1 Self-Determination Theory

SDT is a theoretical framework on human motivation and personality development that had initially been proposed and refined by Ryan and Deci in the 1970s (Ryan & Deci, 2000). The theory suggests that humans have an innate capacity for growth and self-regulation, which can be either supported or hindered by their social environments (Ryan & Deci, 2000).

SDT identifies three universal basic psychological needs: autonomy, competence, and relatedness. These needs are crucial for fostering intrinsic motivation and are strongly linked to achieving better learning outcomes and psychological well-being (Deci & Ryan, 1985; Ryan & Deci, 2017). In educational contexts, these needs are key drivers of students' academic engagement. Studies indicate that fulfilling these needs promotes engagement directly and indirectly, by stimulating intrinsic motivation (Karimi & Sotoodeh, 2020). Conversely, when these needs are unmet, students' motivation and engagement levels tend to decline (Leo et al., 2022). De Loof et al. (2021) demonstrate that students who perceive their basic needs as satisfied are more likely to exhibit autonomous motivation and actively engage in learning.

For instance, students who are confident in their abilities are more likely to focus and engage in tasks, whereas a lack of confidence can reduce the time and effort they invest (Meng & Zhang, 2023). Großmann et al. (2023) argue that, in autonomy-supportive environments, students can set and pursue their own learning goals, thereby strengthening intrinsic motivation and engagement. In environments that promote relatedness, intrinsic motivation is more easily activated, because these environments fulfill the need for connection and belonging (Ryan & Deci, 2000).

2.2 Academic Engagement

Academic engagement is a central construct in education psychology (Stoeber et al., 2011) and commonly describes the extent and quality of students' involvement in learning activities. It serves as a critical indicator for assessing student learning investment and educational outcomes. Early conceptualizations, such as that of Astin (2014), define academic engagement as the physical and psychological energy that students invest in academic and campus activities, which highlights the central role of involvement in the learning process.

Research typically categorizes academic engagement in several dimensions. Fredricks et al. (2004) propose a three-dimensional model that consists of

behavioral engagement, emotional engagement, and cognitive engagement. Behavioral engagement refers to observable actions, emotional engagement captures students' affective responses to learning, such as interest and a sense of belonging, and cognitive engagement involves deep learning strategies. Reeve and Tseng (2011) later added a fourth dimension, agentic engagement, to describe students' proactive efforts to shape their learning environments.

Academic engagement is not only a crucial metric for evaluating the quality of education (Van Uden et al., 2014), but also an essential indicator of students' achievement of meaningful learning outcomes (Reeve, 2012). Research consistently demonstrates a close relationship between academic engagement, academic performance, and broader educational achievements (Oriol et al., 2016; Salanova et al., 2010). Stroet et al. (2013) argue that motivation serves as the internal drive behind behavior, while engagement represents external manifestation.

Numerous studies support the significant role of motivation in shaping academic engagement, particularly when students' basic psychological needs are met. In such cases, motivation acts as a mediating factor that enhances both the quality and persistence of engagement (De Loof et al., 2021). The fulfillment of basic psychological needs, such as autonomy, competence, and relatedness, directly influences the various dimensions of academic engagement, and strengthens students' emotional, behavioral, and cognitive involvement in learning activities.

3. Data and Methodology

3.1 Data Source

To ensure the academic rigor and reliability of this systematic review, Web of Science (WoS) was selected as the sole database for literature retrieval. WoS covers a broad range of relevant disciplines, including education, psychology, and motivational theory, and all indexed publications are peer-reviewed, thus ensuring high academic quality and credibility. Given that this study focused on the relationship between basic psychological needs and students' academic engagement, and adopted SDT as its core theoretical framework, the literature resources available in WoS offer clear advantages in terms of topic relevance and methodological consistency. Additionally, the platform's robust citation tracking and standardized indexing system make it well-suited for bibliometric analysis and trend identification.

During the literature screening process, only peer-reviewed publications were included, along with articles in Online First status. Although these articles may not yet have been assigned to specific journal issues, their content and citation information (e.g., DOI) had been validated, which rendered them reliable sources and valuable supplements for identifying the latest research developments.

A total of 439 publications were identified for analysis.*

The details of the selection process is outlined in Table 1.

Table1: Search Strategy Overview

Search Field	Search Query
Title/Abstract/Author Keywords/Keywords Plus	("Basic psychological needs" OR BPNS) AND (Student OR School) AND ("Engagement" OR "Academic Engagement" OR "Classroom Engagement" OR "participation" OR "involvement" OR "Learning engagement" OR "student engagement" OR "educational engagement")
Timespan	ALL year (comprehensive and systematic review)
Languages	English
Document types	Article; Published online; Review Article;
Research Areas	Psychology; Educational Research; Sport Sciences; Social Sciences Other Topics; Health Care Sciences Services; Linguistics; (Fields related to education)
Literature Search Platform	Web of Science
Date collect day	07/04/2025

3.2 Data Analysis

This study used bibliometric analysis to systematically review journal literature from international sources and found on the WoS database on the themes of basic psychological needs and academic engagement, with the aim of revealing the overall development of this research area. Bibliometric analysis examines the quantity of literature and the citation relationships, author collaboration networks, keyword co-occurrence, and how often certain theoretical models were used, which makes it a comprehensive and structured quantitative research method.

*A list of the 439 publications used in the analysis is available upon request.

VOSviewer was used as the visualization analysis platform. VOSviewer is a specialized software tool that was developed for building and exploring bibliometric networks, and can analyze relationships between scientific publications, journals, researchers, countries, or keywords. Through visual mapping, VOSviewer reveals structural patterns and research trends hidden in large volumes of literature. A successful bibliometric analysis provides a comprehensive structural view of a research field, while also helping researchers identify gaps in existing studies, clarify research entry points, and position their own work in the current academic ecosystem (Genc & Kocak, 2024).

To complement the statistical features that are difficult to present through visual maps, this study imported the core literature into Microsoft Excel to extract and organize information, such as research methods and the distribution of research subjects, and to facilitate content-based quantitative analysis. By combining visual mapping and statistical analysis, this study was able to systematically reveal research trends, hotspot distributions, and structural evolution in the field.

4. Results

4.1 Bibliometric Analysis Results

Figure 1 illustrates the publication trends of literature on the topics of basic psychological needs and academic engagement from 2006 to 2025. Overall, research in this field has evolved in phases, from early exploratory efforts to rapid development, and displays distinct temporal characteristics.

Before 2018, the number of publications was relatively low and increased at a slow pace, indicating the absence of widespread academic consensus on the topic at that time. Research in this early phase focused primarily on theoretical construction and preliminary empirical investigations, with few large-scale or systematic studies. However, since 2018, there has been a significant increase in publications, particularly on topics such as motivational support and psychological well-being. These emerging areas indicate growing academic interest in SDT and its application for enhancing student engagement, particularly after the COVID-19 pandemic. The surge in publications post-2020 suggests a shift toward practical research that addresses students' psychological needs in online learning environments.

The year 2024 marked a peak in the publication of literature in this field, with research reaching new highs in quantity, and also showing diversified characteristics in terms of topics. Emerging hotspots include motivation support in blended learning environments and the relational mechanisms between teacher behaviors and student engagement.

Regarding citation frequency, the upward trend parallels an increase in academic influence. Since 2018, total citations have risen sharply and peaked in 2024. This growth reflects the increasing recognition of research for both theoretical contributions and practical significance and highlights the expanding dissemination and scholarly impact of the field.

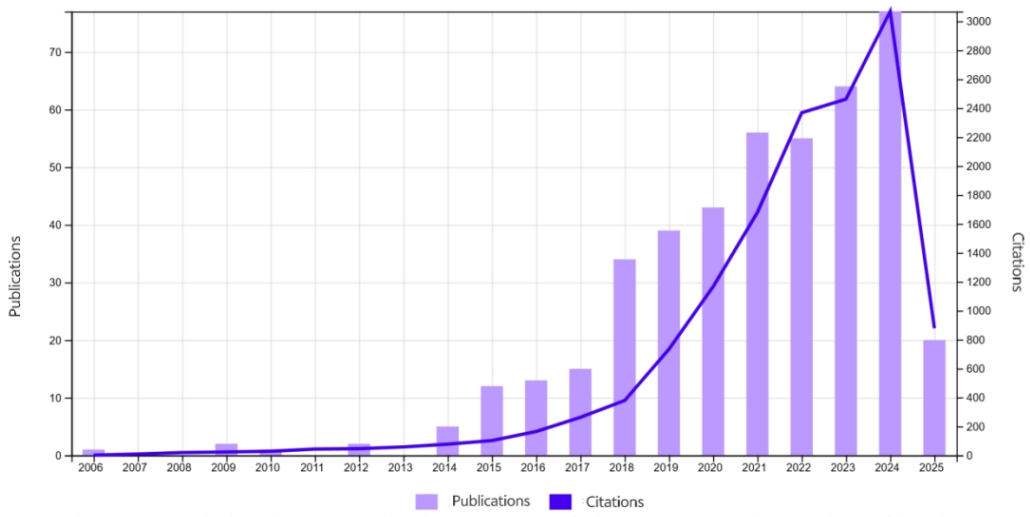

Figure 1: Publication and citation trends of literature on the topics of basic psychological needs and academic engagement from 2006 to 2025

4.2 Author Analysis

4.2.1 Author Productivity and Co-authorship Network

To assess the activity levels of research teams and the structure of academic collaboration in this field, a co-authorship network was constructed using VOSviewer (Figure 2). Overall, this remains an emerging research area, with a relatively limited volume of publications. Therefore, no citation threshold was applied in this analysis. All authors who have published at least one relevant article were included to provide a comprehensive view of the author landscape.

The co-authorship network reveals several distinct clusters centered around research teams grounded in SDT. One prominent cluster is led by Nikolaos Ntoumanis and Kimberley J. Bartholomew, whose research is on motivation and behavioral engagement in the domains of sport and health education (e.g., Bhavsar et al., 2020). Their frequent collaborations position them at the core of the network. Another influential group is represented by Johnmarshall Reeve and Sung Hyeon Cheon, whose East Asian research team emphasizes the role of teachers' support for student autonomy in promoting cognitive and emotional engagement (e.g., Cheon et al., 2018); their work contributes to cross-cultural education discourse.

Meanwhile, Francisco M. Leo and his collaborators in Spanish-speaking contexts have become more productive in recent years; their studies focus on relatedness and agentic engagement in physical education settings (e.g., Leo et al., 2022). Several other research groups focus on the interplay between academic stress, teacher behaviors, and perceived competence of university students, and often employ structural modeling and intervention-based designs (e.g., Shih, 2015).

It is worth noting that, according to the color gradients in Figure 3, the most active authors published mostly between 2020 and 2024. This suggests a marked increase in scholarly attention on the topic in recent years, alongside the continued expansion of international collaboration networks.

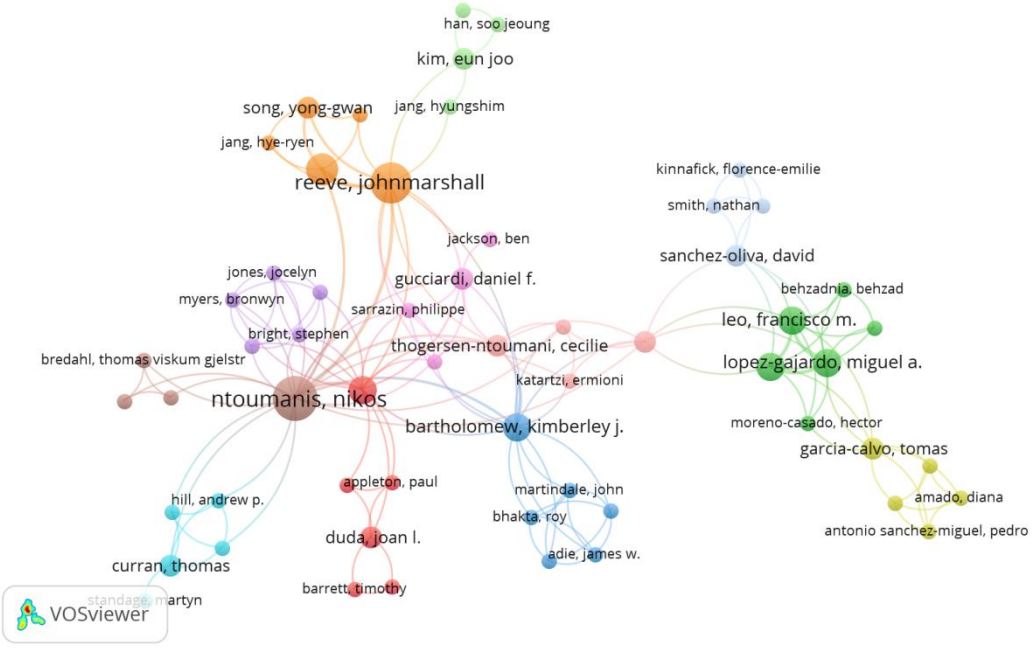

Figure 2: Co-authorship network

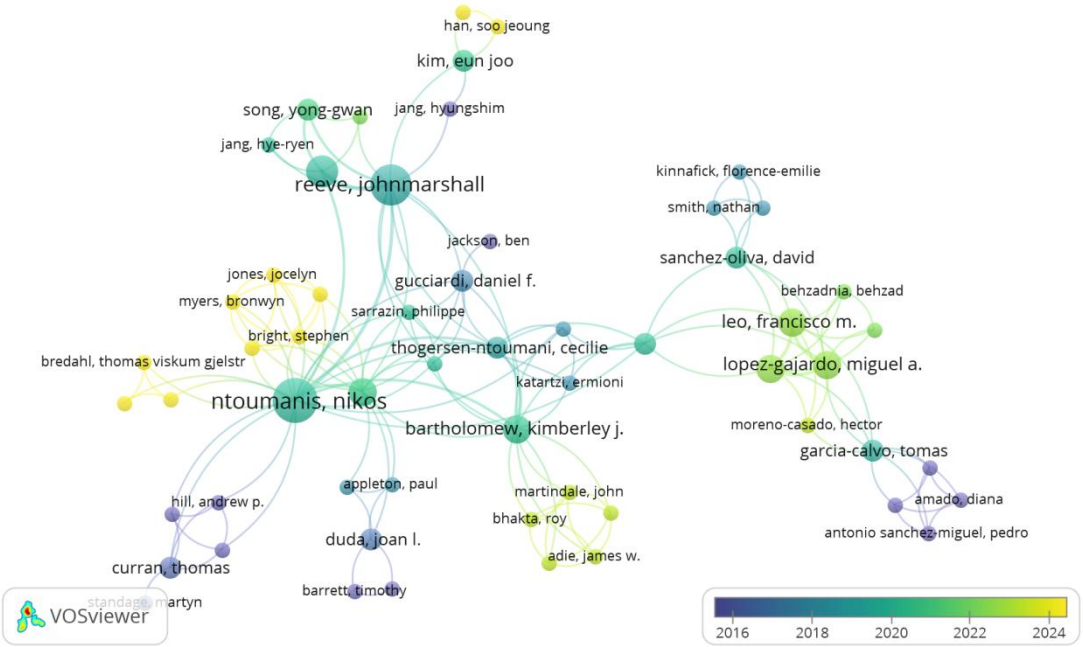

Figure 3: Most active authors

4.2.2 Author Citation Pathway Analysis

To clarify the positioning of core authors in the academic influence chain and map the knowledge transmission pathways in this field, an author citation clustering map was constructed according to unidirectional citation relationships (Figure 4). Unlike the co-authorship network discussed in Section 4.2.1, this visualization

indicates citation flows, thus revealing the structure of academic influence across studies.

The map in Figure 4 displays several stable citation clusters. At the core, a group of early SDT adopters, including Maarten Vansteenkiste, Ntoumanis, Leen Haerens, and Bartholomew, forms a central cluster. Their framework and teacher support → need satisfaction → engagement behavior (Haerens et al., 2015), has become foundational in the field, with numerous subsequent studies citing their work as a model for understanding student motivation (Vansteenkiste et al., 2006).

Another significant cluster centers around East Asian scholars Reeve and Cheon, whose research focuses on teacher autonomy-supportive behaviors in Asian education contexts. Their studies on the role of autonomy-supportive interventions in improving classroom climate and reducing antisocial behavior have had a broad impact on approaches to education in several countries (Cheon et al., 2022).

A third cluster includes scholars such as Chantal Levesque-Bristol, Ryan, and Anja Van den Broeck, who focus on the application of SDT in higher education and online learning. Ryan's work emphasizes the necessity of enhancing motivation and engagement to achieve individual well-being, while Levesque-Bristol's research demonstrates how teacher cues can enhance student motivation and engagement in a variety of education settings (Yu & Levesque-Bristol, 2020). Chinese scholars, including Zhang Wei, Yu Chengfu, and Zhen Rui, form a relatively independent cluster; their research is focused on academic self-efficacy, intrinsic value, and the role of these psychological factors as motivational mediators between engagement intention and academic participation. Their work has contributed to the localization of SDT in China (Zhen et al., 2018).

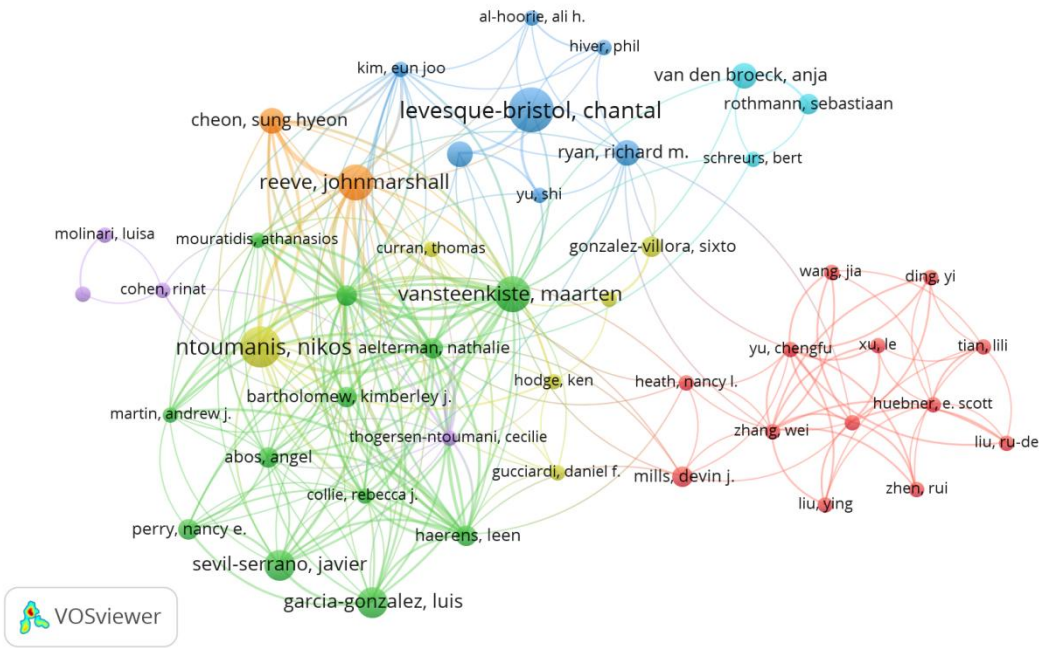

Figure 4: Citation clusters

4.3 Literature Analysis

4.3.1 Analysis of Highly Cited Literature

At the top of the citation ranking is Ryan and Deci (2020), who offer a comprehensive overview of the SDT framework, including a refined definition of basic psychological needs and the differentiation between intrinsic and extrinsic motivation. Their work laid the groundwork for subsequent studies, especially in terms of variable conceptualization and theoretical modeling, and is widely regarded as the primary source of the term's theoretical language and logical structure in the field.

Following closely are several empirical studies that model the pathway of need satisfaction → motivational activation → academic engagement. For instance, Haerens et al. (2015) distinguish between the "bright" and "dark" sides of motivation and propose a dual process model for the context of physical education, thereby extending the structural adaptability of SDT. Jang et al. (2016) employed a longitudinal design to track fluctuations in students' needs and engagement throughout an academic semester and provide empirical support for understanding the dynamic nature of these constructs in real classroom settings. These studies strengthened logic of causal modeling and contributed to a methodological shift from static description to dynamic prediction.

In addition, some of the highly cited works apply SDT to broader contexts. Peters et al. (2018) explored motivational regulation in digital experience design, Schiffrin et al. (2014) examined the influence of parenting styles on college students' well-being, and Trougakos et al. (2020) investigated the link between pandemic-induced stress and motivational regulation from a health psychology perspective. Centraltudies demonstrate that, while learning motivation remains central, SDT has increasingly expanded into cross-domain applications such as family dynamics, technology, and psychological health.

Overall, highly cited publications contribute not only in terms of citation volume but also through their theoretical, methodological, and contextual breadth. SDT-related research is undergoing a gradual transformation, from theoretical articulation and mechanism modeling to cross-situational adaptation. Its sustained academic influence lies in its structural clarity and the high transferability of its core constructs to diverse settings.

Table 2: Top 10 cited articles related to basic psychological needs and academic engagement

Ranking	Content	Publications and authors	Average annual citation frequency	Total
			678.35	13,567
1	Article Title	Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions	344.83	2,069
	Authors	Ryan, R. M., & Deci, E. L.		
2	Article Title	Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation	42.85	857
	Authors	Vansteenkiste, M., & Lens, W.		
3	Article Title	Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation	45.45	500
	Authors	Haerens, L., Aelterman, N., Vansteenkiste, M., Soenens, B., & Van Petegem, S.		
4	Article Title	Why students become more engaged or more disengaged during the semester: A self-determination theory dual-process model	43.9	439
	Authors	Jang, H., Kim, E. J., & Reeve, J.		
5	Article Title	Helping or hovering? The effects of helicopter parenting on college students' well-being	28.5	342
	Authors	Schiffrin, H. H., Liss, M., Miles-McLean, H., Geary, K. A., Erchull, M. J., & Tashner, T.		
6	Article Title	Designing for motivation, engagement and wellbeing in digital experience	40.25	322
	Authors	Peters, D., Calvo, R. A., & Ryan, R. M.		
7	Article Title	Teachers' Relatedness with Students: An Underemphasized Component of Teachers' Basic Psychological Needs	20.57	288

	Authors	Klassen, R. M., Perry, N. E., & Frenzel, A. C.		
8	Article Title	Working in a pandemic: Exploring the impact of COVID-19 health anxiety on work, family, and health outcomes	44.17	265
	Authors	Trougakos, J. P., Chawla, N., & McCarthy, J. M.		
9	Article Title	Classroom social climate, self-determined motivation, willingness to communicate, and achievement: A study of structural relationships in instructed second language settings	21.89	197
	Authors	Joe, H. K., Hiver, P., & Al-Hoorie, A. H.		
10	Article Title	Reexamining the impact of self-determination theory on learning outcomes in the online learning environment	23.43	164
	Authors	Hsu, H. C. K., Wang, C. V., &Levesque-Bristol, C.		

4.3.2 Co-citation Analysis of References

Co-citation analysis reveals the structure of the knowledge community of the field, specifically, which references are frequently cited together in multiple studies, to create the shared foundation of theoretical frameworks and research paradigms. Figure 5 presents the co-citation clustering map of cited references. Based on the clustering structure, the research landscape can be divided into three relatively distinct but interconnected core clusters, each representing a different research orientation: theoretical origins, mechanism pathways, and applied extensions. The red cluster centers on several foundational works by Ryan and Deci (e.g., Deci & Ryan, 2008; Ryan & Deci, 2000a, 2017), including earlier literature defining key concepts such as intrinsic motivation and basic psychological needs (e.g., Deci & Ryan, 1985). This cluster constitutes the theoretical foundation of SDT in education research. It emphasizes human agency, intrinsic motivation, and the universality of basic needs, and has served as a core reference point for variable construction in subsequent empirical studies.

The green cluster focuses on empirical applications of SDT in specific education contexts. Representative scholars include Reeve, Ntoumanis, Jang, and Haerens. This cluster primarily follows the pathway of teacher behavior → need satisfaction → motivational processes → engagement behavior and emphasizes the impact of supportive instructional environments on students' engagement (Haerens et al., 2015; Reeve, 2009). Methodologically, these studies often employ structural equation modeling and mediation analysis, and the pathway has become one of the dominant modeling frameworks in the field.

The blue cluster concentrates on theoretical expansion and cross-contextual applications. It includes early classic studies on student engagement and classroom climate, such as that of Fredricks et al. (2004), as well as research that

extends SDT into new education settings, such as that of Niemiec and Ryan (2009) and Peters et al. (2018). These studies explore SDT's applicability in traditional education settings and expand the framework into areas such as digital learning environments and motivational dynamics.

In their comprehensive review, Vansteenkiste et al. (2020) outline several key directions for future research: the need to consider the moderating role of psychological distance, and the fit between need-supportive practices and individual characteristics (particularly cultural and family background), and how contextual features influence the effects of both need support and frustration. These themes align closely with the focal points of the blue cluster, especially in promoting the broader application of SDT in diverse education settings.

Taken as a whole, the co-citation network reveals a relatively stable theoretical core in the field, which is unified by the central concepts of SDT and structured around three interrelated pillars: need satisfaction, motivational processes, and engagement behavior.

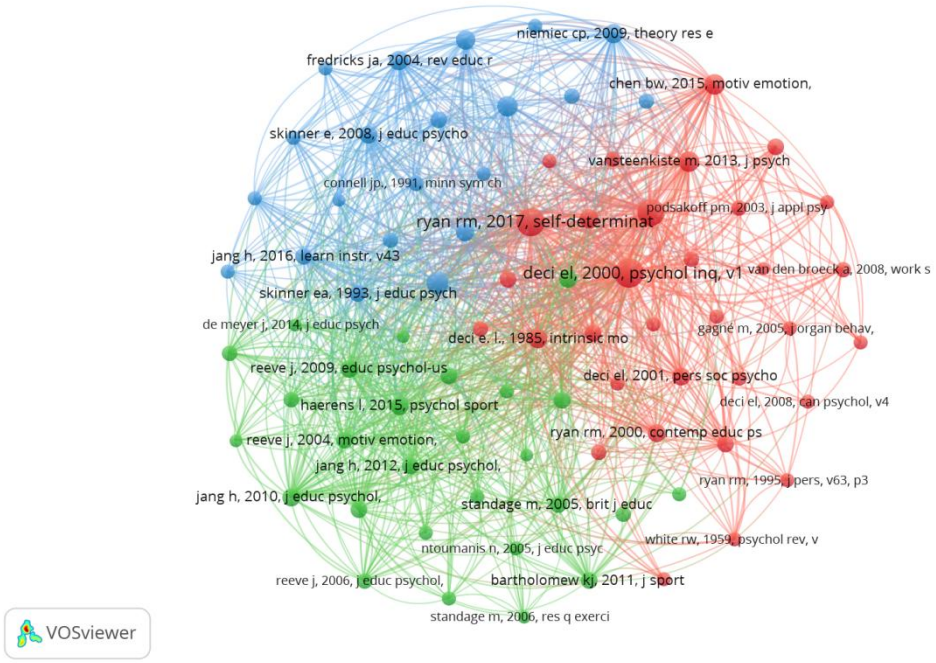

Figure 5: Co-citation clustering map of cited references

4.4 Country-Level Analysis: International Collaboration Structure and Knowledge Influence

To provide a comprehensive overview of the global research landscape in the field of basic psychological needs and academic engagement, this investigation constructed two country-level visualizations: a co-authorship network map and a citation network map (see Figures 6 and 7). These maps reflect, respectively, "who conducts research together" (collaborative relationships), and "whose research is widely cited" (theoretical influence), thus offering dual perspectives on the international dynamics of the field.

Figure 6 presents the international co-authorship network. In this map, each node represents a country, with node size indicating the number of publications, edge thickness showing the frequency of collaboration with other countries, and node color denoting the average publication year (ranging from dark blue to bright yellow, representing 2020 to 2024). The structure reveals that the United States, United Kingdom, and Canada are central to the collaborative network, with dense interconnections. These countries have long maintained stable academic partnerships and have supported the sustained development of SDT in education research.

China, which has emerged as a prominent contributor in recent years, is represented by a large node with a bright yellow hue, which indicate that its research activity has intensified over the past three years. Although not yet at the core of the global collaboration network, China has established close ties with the United States, the Netherlands, Australia, and Spain. It is steadily transitioning from a peripheral participant to a regional hub.

In addition, countries such as Spain, the Netherlands, and Australia function as important bridges within the network, by linking North American and European academic communities with those in Asia and Latin America. While smaller in size, countries such Vietnam, Turkiye, and Malaysia appear in bright yellow, which suggests growing research activity and potential, despite scholars in these countries have not yet become deeply embedded in increasingly stable international collaboration networks.

Figure 7 illustrates the citation network structure at the national level. Here, node size represents total citation frequency, edge thickness indicates citation strength between countries, and node color again reflects recent activity. This map highlights the global knowledge influence of research in each country. The United States remains at the center of the citation network, which reflects its role as the primary originator of SDT and its widespread theoretical dissemination. Strong citation ties connect the United States with the United Kingdom, Belgium, and Canada, thereby forming a core knowledge transmission network dominated by Western countries.

China occupies a large node in this map; a bright yellow tone indicates a sharp rise in citation frequency in recent years. Notably, while China's position in the co-authorship map is more peripheral, its prominence in the citation network suggests that it is evolving from a research collaborator into a knowledge contributor. Chinese models and empirical studies on motivational regulation, instructional adaptation, and student psychological mechanisms are increasingly acknowledged by the international academic community.

It is also worth noting that non-English-speaking countries such as Iran, Vietnam, and Saudi Arabia are showing consistent growth in citation frequency, as indicated by brightly colored nodes. This reflects the expanding application of SDT in response to rising interest in education reform and mental health issues in developing regions, which indicates the theory's growing cultural reach.

The co-authorship and citation maps offer complementary insights into the evolving international research landscape. While developed countries continue to anchor the theoretical core, emerging contributors such as China are gaining influence, thereby diversifying the collaboration network and expanding scholarly reach. The global research map is shifting from a Western-dominated model to a more multi-centered structure, thereby enriching the diversity of perspectives applying SDT. However, the continued dominance of Western countries in setting the theoretical agenda, coupled with possible language barriers, limits the integration of diverse perspectives into the core SDT framework. Future international collaboration should address these imbalances.

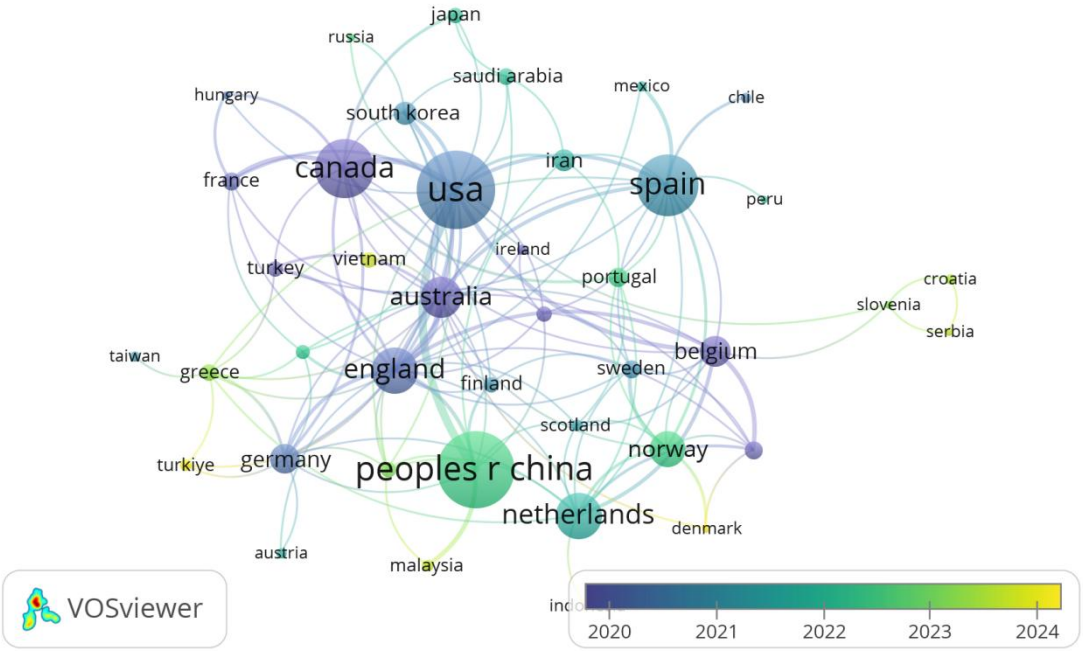

Figure 6: International co-authorship network map

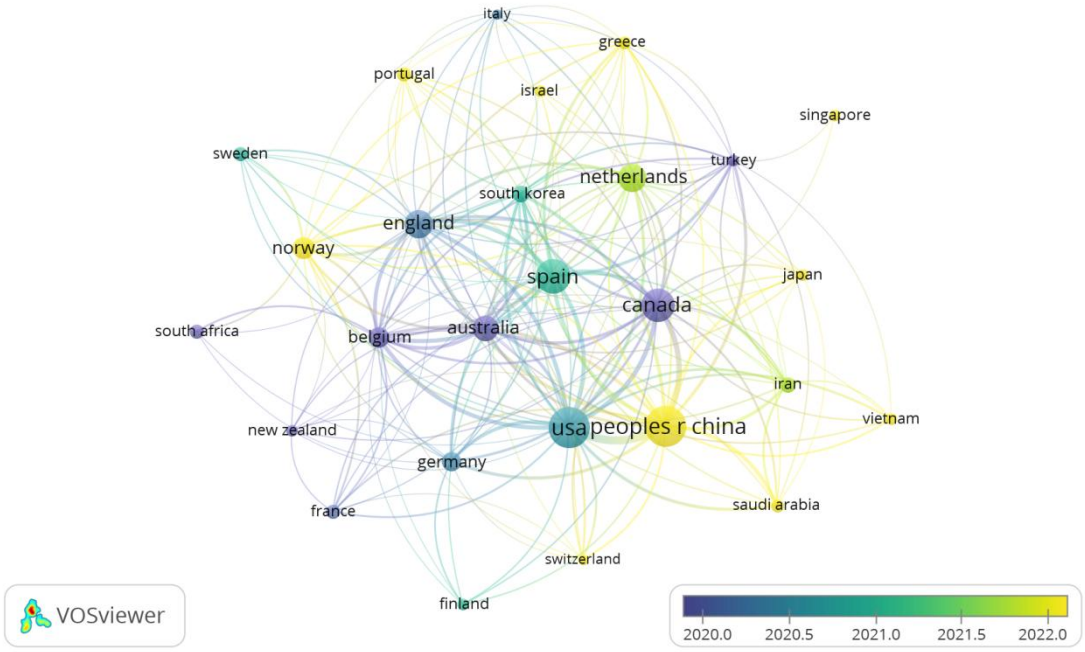

Figure 7: Citation network map

4.5 Keyword Co-occurrence and Cluster Analysis

Furthermore, to identify the core themes and structurally embedded research hotspots in this field, a keyword co-occurrence map was constructed according to all keywords (see Figure 8). A minimum occurrence threshold of 15 was set, which resulted in 49 high-frequency keywords being included for cluster analysis. This visualization captures the core content of current research and reveals a layered knowledge ecosystem encompassing four levels: theory, mechanism, application, and methodology.

At the theoretical foundation level, keywords such as self-determination theory, basic psychological needs, and motivation form a central cluster with high frequency and strong interconnections, which reflects the field's deep reliance on the SDT framework. These terms serve as starting points for variable selection and indicate a high degree of theoretical consensus among scholars.

At the mechanism level, frequently co-occurring terms such as autonomy support, intrinsic motivation, satisfaction, and mediating role reflect dominant modeling logic. Researchers often need satisfaction as a mediating variable to examine how supportive environments stimulate intrinsic motivation, which influences engagement or academic performance. This pathway has become a mainstream framework for both theoretical modeling and empirical analysis.

At the application context level, education terms such as student engagement, academic achievement, and classroom appear alongside health-related terms such as exercise, well-being, and burnout. This illustrates SDT's expansion into diverse real-world settings, such as physical education, psychological regulation, and

stress intervention, thereby demonstrating its contextual adaptability and transferability.

At the methodological level, keywords such as scale, model, intervention, and fit indexes indicate a growing emphasis on structural modeling and path analysis as core research paradigms. This reflects a trend toward methodological standardization and integrating theoretical logic with empirical data support.

Notably, keyword engagement appears in multiple clusters, where it functions both as an outcome variable and a theoretical mediator, to reflect its integrative role across diverse research trajectories. Similarly, the three core dimensions of basic psychological needs—autonomy, competence, and relatedness—are embedded in various semantic clusters, which indicates a shift from holistic theory construction to more fine-grained, dimension-based mechanism research. The keyword co-occurrence map reveals an evolution in research themes. Core terms such as self-determination theory, basic psychological needs, and motivation remain central, to reflect foundational theories.

However, newer terms such as online learning, mental health, and COVID-19 emerged after 2022, signaling a shift toward applied research that addresses real-world challenges. This trend illustrates the growing intersection of SDT with contemporary education issues, such as mental health and digital learning environments. The map presents a structured, hierarchically organized research network, with interlinked clusters, forming a coherent representation of the research landscape in basic psychological needs and academic engagement.

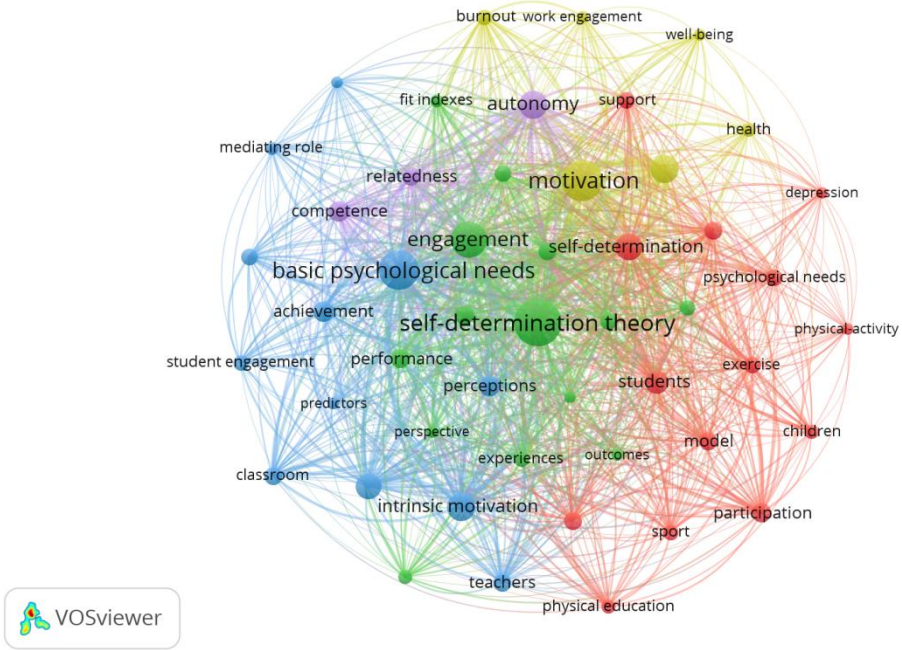

Figure 8: Core themes and structurally embedded research hotspots

4.6 Research Trend Analysis

4.6.1 Evolution of Author Keywords and Keywords Plus

To identify the temporal evolution of research themes, this study constructed time-based co-occurrence maps for both author keywords and keywords plus (see Figures 9 and 10) by examining research trends from two complementary perspectives: researcher-defined terms and database-extracted terms. In both visualizations, node color ranges from dark blue to bright yellow, indicating increasing research activity from 2020 to 2024.

The author keyword time map (Figure 9) shows that core themes such as motivation, self-determination theory, and basic psychological needs remain central. Keywords such as autonomy support, intrinsic motivation, and engagement have gained prominence, which highlights a focus on variable path modeling and mechanism-based structures. Emerging topics on the periphery since 2022, such as online learning, mental health, resilience, and COVID-19, reflect the field's expansion into applied areas such as digital education, mental health regulation, and crisis adaptation.

The keywords plus time map (Figure 10) captures a broader thematic spectrum, with terms such as academic achievement, school engagement, performance, and education indicating a shift toward outcome-based research. This reflects the increasing integration of SDT into studies on academic success and educational outcomes.

Rising activity for keywords such as stress, health, depression, and intervention signals an intersection with interdisciplinary domains, particularly mental health and emotional regulation, which underscores the role of SDT in understanding individual adjustment and learning motivation.

Collectively, these trends show a pivotal evolution: while core SDT constructs remain central (author keywords), research is expanding into critical applied domains such as mental health, online learning resilience, and targeted interventions (keywords plus). This signifies an increasing focus on leveraging SDT to address contemporary educational and psychological challenges, thereby moving beyond mere mechanism validation. Integrating SDT across education, psychology, and health positions is strongly for future work in areas such as cross-cultural adaptation and technology-enhanced learning. However, the rapid emergence of applied keywords such as intervention requires careful consideration to ensure that these efforts are grounded in robust SDT mechanisms and are rigorously evaluated, instead of being superficial applications.

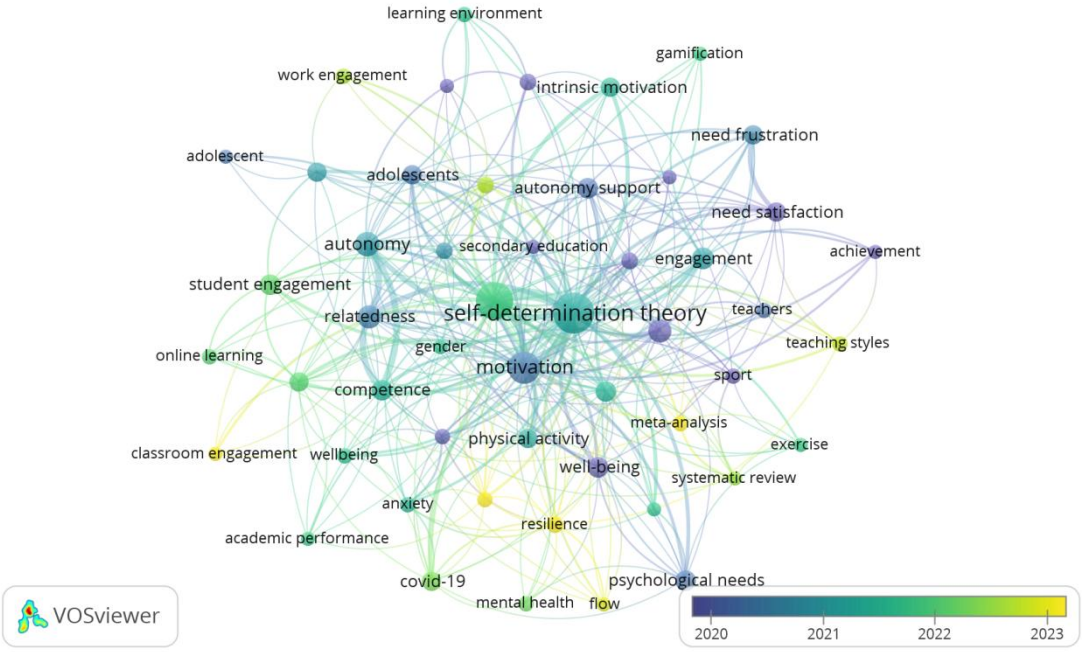

Figure 9: Author keyword time map

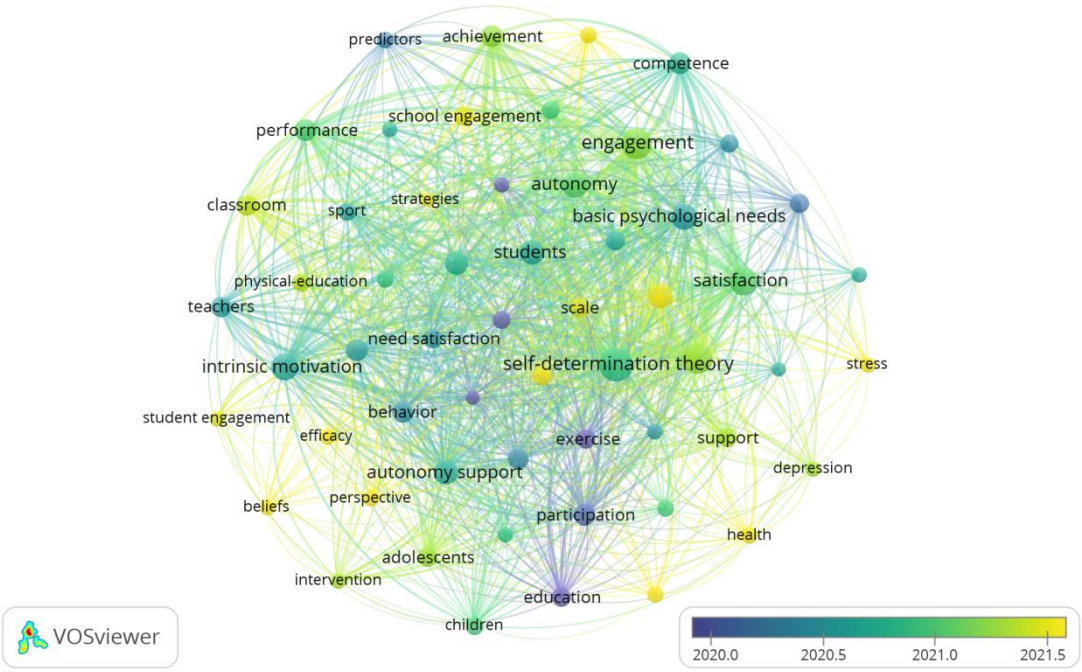

Figure 10: Keywords plus time map

4.6.2 Dominant Research Approaches and Target Populations

Analysis of the 439 included article abstracts reveals a pronounced quantitative orientation in research on basic psychological needs and academic engagement, with a distinct focus on specific learner populations. Consistent with keyword clustering results (e.g., scale, model), purely quantitative approaches dominate the methodological landscape, where structural equation modeling and cross-

sectional survey designs prevail. Experimental (51 studies) and longitudinal designs (38 studies) indicate growing interest in causality and dynamics, while qualitative (33 studies) and mixed approaches (30 studies) remain significantly underrepresented. Systematic reviews (15 studies) suggest theoretical consolidation trends.

Concurrently, analysis of explicitly identified participant groups (160 studies) shows strong concentration on traditional student populations in formal education. University students constitute the largest subgroup (55 articles), followed by high school (43 articles) and elementary school students (31 articles). Middle school students (10 articles), graduate students (13 articles), and, particularly, vocational college students (8 articles) receive markedly less attention. Non-traditional learners (e.g., adult education) are minimally represented.

This dual methodological and demographic focus creates critical knowledge gaps. The scarcity of qualitative and longitudinal designs limits exploration of contextual nuances and temporal evolution of psychological need fulfillment—core dynamics emphasized by SDT. Additionally, neglecting vocational, adult, and transitional learners undermines SDT's universal applicability, because autonomy, competence, and related operations in diverse educational ecologies remain poorly understood. Addressing these imbalances through methodological diversification and inclusive sampling is essential for advancing SDT's theoretical robustness and developing equitable educational practices that serve all learners.

5. Discussion

5.1 Analysis of Current Research Hotspots

SDT has become the core theoretical framework in this field, and its established pathway of basic psychological needs → motivation → academic engagement exhibits remarkable stability and universality. This pathway has been validated for various educational levels and disciplinary backgrounds, to prove the broad applicability of SDT. The analysis of high-frequency keywords clearly indicates the focal points of research in the past two decades. On the one hand, there is a deepening exploration of core concepts, such as the subdivision of academic engagement into emotional, behavioral, cognitive, and agentic (agentic engagement) dimensions.

On the other hand, there is a focus on uncovering key mechanisms, as seen in the frequent use of terms such as autonomy support, agentic engagement, and mediating role, which suggests that researchers are delving into the complex interactions between these variables. Additionally, the rise of keywords such as online learning, mental health, and resilience signals an expanding focus on practical issues in education and emerging contexts.

From an academic perspective, the author clustering and citation path analysis illustrate a clear theoretical lineage in the field. The work of the founders Ryan and Deci remains the foundation for most research, while later scholars such as Reeve and Ntoumanis significantly advanced SDT theory by applying it to more

complex education contexts. Their ongoing contributions have been crucial to the rapid growth of this field in recent years.

At national levels, the research landscape is undergoing significant changes. While it was traditionally dominated by Western countries such as the United States, the United Kingdom, and Canada, the research center is now diversifying. Notably, China's rise is evident, as it has rapidly increased its publication output, international collaborations, and influence. Countries such as Spain (focused on physical education), the Netherlands (emphasizing innovation in models and methods), and Australia are showing unique research characteristics and connectivity. The increasing research activity of emerging countries such as Vietnam, Iran, Malaysia, and Turkey also signals broader regional involvement.

This shift from a single-center output model to multi-regional interaction signals that SDT is extending its reach across cultural boundaries and entering a variety of educational systems and societal contexts. Importantly, this is not merely a geographical expansion but also a diversification of theoretical content and research methodologies. For instance, in East Asian cultures, autonomy is often interpreted through a collectivist lens; in education systems with constrained resources, teacher support may be limited by institutional structures. These realities are prompting scholars to adjust the internal logic of SDT to enhance its alignment with local conditions.

5.2 Evolution of Research Trends

An in-depth analysis of the bibliometric maps shows that the research focus, pathway structure, and research methods in this field are undergoing significant evolution. The research focus is gradually shifting from an exploration of SDT's theoretical mechanisms to a greater emphasis on the complexity of real-world issues and contexts of education. Early studies concentrated mainly on verifying the relationship between basic needs and types of motivation; in contrast, current trends are increasingly focused on dynamic changes in motivation in online learning environments, the specific role of autonomy-supportive teacher behaviors, student mental health issues, and strategies for learning adaptation in special contexts, such as the COVID-19 pandemic. This shift has encouraged the embedding of SDT into more complex educational systems, with the research goal evolving from simply explaining "why students engage" to exploring "how to sustain engagement" in practice.

Regarding research pathways, while basic psychological needs → motivation → academic engagement remains the core chain, its manifestation has evolved from a relatively simple, linear form to a more multidimensional, hierarchical structure. This evolution reflects researchers' more refined exploration of variable mechanisms, such as focusing on differences in motivation types, the breakdown of engagement dimensions, and the influence of mediating (e.g., self-efficacy, emotional regulation) and moderating (e.g., cultural background, teacher style) variables. The frequent appearance of keywords such as autonomy support, agentic engagement, and mediating role reflects this trend toward mechanistic modeling.

Another significant trend is the expansion of research contexts, which now extend from traditional classroom environments to physical education, online learning, family education, and even learning adaptation in global crises such as the pandemic. This diversification of research forces models to account for more uncertainty and specificity, which drives the complexity and diversity of pathway structures further.

Of particular note is the growing exploration of cultural adaptation globally. Researchers with non-Western backgrounds, including those from Asia, South America, and the Middle East, are increasingly applying SDT to local educational practices. These efforts have transformed the research pathway from a rigid, universal logic to a flexible tool that can be adjusted according to different cultural and societal contexts. The current multidimensional, dynamic research paths reflect researchers' deep understanding of the complexity of student academic engagement and have driven a critical reflection on the applicability of existing theoretical models, which marks a shift from seeking a unified paradigm to embracing multiple constructions.

Regarding research methods and populations, the field shows distinct characteristics and evolving needs. Quantitative methods remain dominant, with researchers primarily using surveys and structural equation modeling (such as path analysis and structural equation modeling) to verify theoretical pathways. However, methods capable of capturing dynamic processes, such as experimental interventions, mixed methods (combining quantitative and qualitative approaches), and longitudinal tracking designs, are relatively underused. The reliance on static, cross-sectional data suggests that current research is primarily focused on structured analyses, which limits the ability to capture dynamic changes in variable relationships over time or with interventions.

There is also a notable concentration in research populations, with university and secondary school students forming the majority of the sample base, while elementary and vocational education groups are underrepresented. This limitation in research populations restricts the breadth of the applicability of STD and hampers the expansion of educational interventions that are based on this theory in different education stages and groups. Future research should break through the limitations of static analysis and expand the coverage of research populations, to more comprehensively assess the applicability and practical value of the theory.

5.3 Research Limitations and Future Directions

Despite significant progress, current research still faces several structural limitations that indicate avenues for future exploration. The most prominent limitation is in the depth of theoretical integration. Most studies tend to focus on specific segments of the needs → motivation → engagement chain, with relatively few studies systematically integrating the entire chain into a unified framework.

This "partial validation, less integration" issue weakens the field's ability to fully explain complex phenomena in education. Furthermore, while there is significant

theoretical consistency across studies, the application of SDT is fragmented. Although emerging contexts, such as online learning, COVID-19, and flipped classrooms, continue to surface, there is often a lack of consistency in research goals and measurement tools. Some studies use SDT as background theory without establishing a rigorous logical pathway between SDT and empirical issues, resulting in a disconnect between theory and practice.

Additionally, while research regions are expanding, truly systematic cross-cultural comparative studies remain scarce. SDT's adaptability and operational feasibility for different cultural backgrounds and educational systems remain underexplored. Limitations of research methods are also evident in a strong reliance on static, cross-sectional data, and insufficient use of longitudinal tracking, experimental interventions, and other dynamic research designs to capture evolving relationships and causal mechanisms. Furthermore, there is a narrow range of research populations, with an obvious lack of focus on groups such as elementary school children and vocational education students, thereby limiting the universality of the theory and its practical application.

Looking forward, future research should deepen theoretical integration by developing more systematic variable models that address the generation of motivation, as well as its maintenance, transformation, and ultimate behavioral outcomes. This would require more rigorous methodological strategies, such as structural equation modeling, longitudinal tracking, and experimental designs, to better capture dynamic processes in education settings. Cross-cultural comparative studies also need to be expanded, particularly in collectivist cultures and highly structured educational systems, where concepts such as autonomy and teacher support need to be reconsidered in light of contextual realities.

Moreover, with the growing prevalence of AI technologies and hybrid learning environments, future studies should explore how SDT can be meaningfully integrated into these evolving education contexts. These efforts will enhance the contemporary relevance of SDT, while also providing more context-sensitive strategies for improving student motivation and academic engagement.

6. Conclusion And Implications

This study conducted a bibliometric review of research on basic psychological needs and academic engagement that engaged the SDT framework. The analysis reveals a stable and widely accepted model that links satisfaction, motivation, and academic engagement. However, it is clear that research in this field has evolved toward more complex, multi-pathway models and has expanded to include emerging areas such as online learning, mental health, and resilience, particularly in the context of the COVID-19 pandemic. The increase in contributions from regions such as China has enriched the diversity of SDT applications by adding new dimensions to the theory.

While the theoretical foundation of SDT remains robust and widely validated, certain limitations persist regarding methodological diversity and population inclusion. Particularly, there is a notable gap in research focusing on vocational

students and intervention-based studies. To foster more practical applications, educators must focus on creating autonomy-supportive environments in digital learning contexts, while also providing targeted support to marginalized groups, to ensure that all learners have the opportunity to engage meaningfully. Furthermore, policies should be designed to encourage cross-cultural validation of SDT and promote mixed-methods research that explores the sustainability of engagement across various contexts.

A significant limitation of this study lies in its sole reliance on the WoS database, which may have introduced a publication bias toward Anglophone literature and underrepresentation of research from the Global South. Future research should incorporate a variety of databases, such as Scopus and Dimensions, to provide a more balanced and comprehensive review. Additionally, it could be beneficial for future studies to include quality-weighting protocols and adopt longitudinal designs to better capture the dynamic nature of motivation and engagement, particularly in cross-cultural and online educational contexts.

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