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Classrooms to Networks: Applying Connectivism Principles in Pedagogy

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Abstract
The integration of digital technologies has led to a significant transformation in educational practices, shifting from traditional classroom models to more dynamic, networked learning environments. This paper explores the concept of connectivism, a learning theory developed by Siemens and Downes, which emphasizes the importance of networks, connectivity, and collaboration in acquiring knowledge. Unlike traditional pedagogies that focus on content delivery, connectivism promotes the creation and navigation of networks to facilitate continuous learning. Key principles of connectivism include the diversity of opinions, the distribution of knowledge across networks, and the critical role of digital tools in learning processes. The paper discusses the practical applications of connectivism approaches in contemporary pedagogy, focusing on how educators can transform traditional classrooms into engaging, networked learning spaces. Despite its theoretical strengths, the implementation of connectivism faces challenges, including technological access, information management, and the need for pedagogical adaptation. Through this exploration, the paper aims to provide insights into how connectivism can enhance educational practices and prepare students for the complexities of a rapidly evolving, networked society.
Keywords: *Collaborative Learning; Connectivism; Digital Learning; Education Theory*

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Introduction
The integration of digital technologies has significantly influenced the evolution of educational practices, leading to a shift from traditional classroom models to more dynamic, networked learning environments. Traditional educational frameworks often focus on individual knowledge acquisition within the confines of a closed classroom setting. However, these models are insufficient in preparing students for a world where information is dispersed across networks and is continuously evolving (Siemens, 2005). There remains a challenge in effectively bridging traditional classroom practices with the inherently networked nature of modern knowledge and learning.

Connectivism, introduced by George Siemens and Stephen Downes, serves as a theoretical framework that addresses this shift by emphasizing the significance of networks in the learning process. Unlike conventional pedagogies, which prioritize content delivery by instructors, connectivism focuses on the importance of connectivity, collaboration, and digital literacy in knowledge acquisition (Siemens, 2005).

The principles of connectivism advocate for moving away from isolated, traditional classroom settings to networked learning environments, where students actively engage with a variety of information sources and collaborate across digital platforms. This approach acknowledges that, in the

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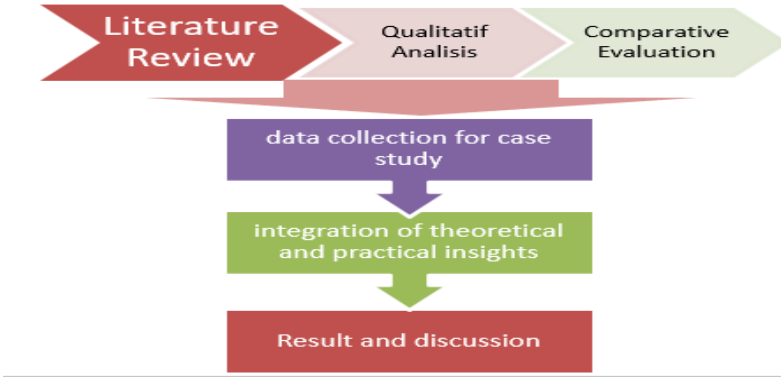
digital age, the ability to locate and apply information is often more essential than merely possessing knowledge. By applying connectivism principles, educators can create learning experiences that better reflect how information is accessed and disseminated in real-world contexts.

Although connectivism has garnered attention within educational discourse, there is still a lack of comprehensive frameworks for its practical implementation across diverse educational settings. Kop and Hill (2008) observe that while connectivism offers a valuable perspective for understanding learning in the digital era, its practical implications for teaching methodologies have yet to be thoroughly explored.

This paper aims to examine the practical applications of connectivism in modern pedagogy, focusing on how educators can transform traditional classrooms into dynamic learning networks. It will discuss strategies for implementing connectivism approaches, identify potential challenges, and assess their impact on student engagement and learning outcomes. Through this exploration, the paper seeks to provide insights into how connectivism can enhance educational practices and better equip students for the complexities of a networked society.

Methodology

The methodology employed in this paper adopts a qualitative approach, focusing on a comprehensive review and analysis of existing literature related to the principles and application of connectivism in modern education. By synthesizing theoretical frameworks proposed by key scholars, including Siemens (2005) and Downes (2010), the study examines how connectivism principles can be integrated into classroom settings to foster more dynamic, networked learning environments. The research method involves an in-depth analysis of existing pedagogical models and educational practices, with a particular focus on identifying strategies for implementing connectivist learning theories effectively. The study also evaluates case studies and examples of practical applications of connectivism, exploring how digital tools, network-based learning, and collaborative methods can enhance student engagement and learning outcomes. Additionally, the article addresses the challenges faced in adopting these approaches, such as issues related to technology access, information overload, and the shift in pedagogical roles.



Picture 1. a step-by-step process that integrates both theoretical and practical insights

Result and Discussion

The research question seeks to explore practical methods for integrating the principles of connectivism into contemporary educational practices. Connectivism, as introduced by Siemens (2005) and further elaborated by Downes (2010), emphasizes the importance of networks, digital tools, and collaboration in the learning process. The article "Classrooms to Networks: Applying Connectivism Principles in Pedagogy" provides a comprehensive exploration of how these principles can be translated from theory into practical educational strategies.

How the Findings Were Generated

The findings in this paper are derived from a thorough review of existing literature on connectivism and its applications, combined with an analysis of current educational practices that have

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successfully implemented connectivism principles. I synthesized insights from key studies, including foundational works by Siemens (2005), Downes (2010), and Kop & Hill (2008), as well as more recent research on digital learning tools, project-based learning, and student autonomy (Bell, 2011; Dunaway, 2011; Transue, 2013). I draw on practical examples, case studies, and empirical evidence from educational contexts where connectivism approaches have been applied, such as in project-based learning environments and digital platforms like MOOCs. The detail of how this paper arrived at its findings, are as follows;

1. Literature Review and Theoretical Analysis
   I begin by conducting a thorough review of foundational theories on connectivism, primarily focusing on works by Siemens (2005) and Downes (2010). This theoretical analysis establishes the core principles of connectivism, such as the importance of networks, connectivity, and the digital nature of modern knowledge acquisition.
   Then, I identify networked learning as a fundamental principle of connectivism. I emphasise that effective integration of connectivism in modern education requires students to engage with diverse information nodes, including peers, digital tools, and online resources. This foundational understanding serves as the basis for the development of practical strategies discussed later in the article.
2. Identification of Practical Gaps in Existing Research
   By examining previous studies, including those by Kop & Hill (2008), Bell (2011), and Dunaway (2011), I highlight a gap between the theoretical underpinnings of connectivism and its practical application. While earlier research provides a conceptual framework, there is a lack of clear strategies for educators to implement connectivism in classrooms.
   This analysis leads to the realization that there is a need for practical, actionable strategies to integrate connectivism into education. Afterward. I generate the key finding that educators must shift from traditional content delivery to facilitating networked learning, where students build their own learning networks and engage with real-world problems.
3. Case Studies and Examples from Educational Practices
   I draw on real-world examples and case studies of educational practices that have successfully integrated connectivism principles. Examples include the use of project-based learning (PBL), digital platforms like MOOCs, and collaborative online projects. For instance, the paper discusses how students engaging in PBL can develop critical thinking and problem-solving skills by collaborating across digital platforms.
   Next, through these examples, I identify the effectiveness of PBL and digital platforms in fostering networked learning. This leads to the finding that project-based activities and collaborative tasks are effective ways to implement connectivism, as they encourage students to connect various information nodes and apply their knowledge in practical contexts.
4. Analysis of Challenges and Barriers
   To understand the difficulties of applying connectivism, I analyse challenges highlighted in previous studies, such as the digital divide (Norris, 2001), information overload (Tsai & Ghoshal, 1998), and issues of self-regulation (Zimmerman, 2002). The paper examines these challenges in the context of digital learning environments, offering solutions based on real-world educational settings.
   This leads to the finding that addressing digital literacy, providing teacher support, and developing critical thinking are essential to overcoming barriers in implementing connectivism. I emphasise that for connectivism approaches to succeed, educators need to be trained to guide students in navigating digital tools and developing self-regulation skills.
5. Integration of Digital Literacy and Real-World Application
   I integrate insights from studies on digital literacy (Transue, 2013) and experiential learning (Kolb, 1984) to highlight the importance of teaching students to navigate digital networks. It also discusses how applying real-world issues in the curriculum, such as debates on renewable energy, can help students understand the relevance of their learning.
   The synthesis of these insights results in the key finding that digital literacy and real-world application are crucial components of modern education. The paper emphasizes that teaching students how to effectively use digital tools and apply their learning to solve real-world problems is central to the successful integration of connectivism principles.

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6. Comparative Analysis with Traditional Educational Models
   Throughout the paper, there is a comparative analysis between traditional content-focused educational models and the networked, student-led approach advocated by connectivism. By contrasting these models, I demonstrate the limitations of traditional teaching in a digital age and underscores the advantages of a connectivism approach.
   Key Finding Generated: This comparison generates the finding that modern education systems must shift from teacher-centered to student-centered learning, where educators act as facilitators, helping students build personal learning networks. The emphasis on student autonomy and self-directed learning is a core element of this shift.

Table 1. Summary How the Key Findings generate

Method Use	How the findings generate
Literature Review & Theoretical Analysis	Establishes foundational principles of connectivism and identifies the need for networked learning in modern education.
Identification of Practical Gaps	Highlights gaps in previous research, leading to the finding that there is a need for practical strategies to implement connectivist principles effectively.
Case Studies & Real-World Examples	Uses real-world examples to demonstrate effective methods like PBL, digital platforms, and collaborative projects, leading to findings on practical integration strategies.
Analysis of Challenges & Barriers	Examines barriers such as the digital divide, information overload, and self-regulation, leading to the finding that digital literacy and teacher support are essential.
Integration of Digital Literacy & Real-World Issues	Combines insights from digital literacy and experiential learning studies, generating the finding that these elements are central to effective connectivist learning.
Comparative Analysis with Traditional Models	Compares traditional and networked educational approaches, generating the finding that student-centered, networked learning is more effective in a digital age.

As can be seen from the table 1, this paper integrates theoretical insights, practical strategies, and a comprehensive analysis of challenges to provide a clear framework for applying connectivism principles in modern education. Each key finding is systematically generated through a combination of literature review, case studies, and analysis, emphasizing the need for digital literacy, practical problem-solving, and a shift towards student-cantered, networked learning.

The structured approach presented in the table illustrates that this paper not only supports the theoretical principles of connectivism but also extends them by offering actionable recommendations. This makes the findings relevant and applicable to real-world educational settings, addressing the core research question of how connectivism can be effectively integrated into modern education systems.

Interpretation of the Findings

This paper identifies several key strategies for effectively integrating connectivism principles into modern education:

1. The research underscores the centrality of network formation and navigation within the connectivism paradigm. This theoretical framework posits that educators should facilitate students' development of personalized learning ecosystems, encompassing a diverse array of resources including digital platforms, subject matter experts, and peer collaborators. The study emphasizes the critical nature of digital literacy competencies, which enable learners to effectively traverse, scrutinize, and evaluate information across various technological interfaces, such as learning management systems and video conferencing tools for example google classroom and zoom. Moreover, the research advocates for the implementation of collaborative endeavors as a means to cultivate these essential skills. This approach aligns with

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Siemens' (2005) conceptualization of connectivism, which emphasizes the distributed nature of knowledge across networks. The focus on digital literacy and network navigation skills echoes the work of Downes (2010), who highlighted the importance of learners' ability to critically engage with diverse information sources. Furthermore, the emphasis on collaborative projects as a vehicle for skill development resonates with the findings of Dunaway (2011), who explored the pedagogical implications of connectivism in networked information landscapes.

2. Practical Strategies for Implementation: I provide a detailed discussion on practical strategies, including project-based learning (PBL), which allows students to apply theoretical knowledge to real-world problems. This approach aligns with the principles of connectivism by emphasizing the importance of learning through doing, connecting with various information sources, and fostering critical thinking (Kolb, 1984; Johnson & Johnson, 2009). By integrating project-based tasks that require collaboration and the use of digital tools, educators can create a more dynamic and engaging learning environment. Previous studies, such as those by Dunaway (2011) and Bell (2011), acknowledged the potential of connectivism but did not elaborate on how to implement it in structured educational activities. I address this gap by offering concrete examples of how PBL can facilitate networked learning.

3. Supporting Student Autonomy and Self-Regulation: Another key finding is the emphasis on student autonomy. The article argues that, for connectivism to be effective, students need to be active participants in their learning, capable of self-regulation and critical thinking. This aligns with earlier theories by Vygotsky (1978) on the social aspects of learning and Wenger (1998) on communities of practice. However, the current article goes further by discussing how educators can cultivate these skills through scaffolding and guidance. For example, encouraging students to pursue self-directed projects and connect with online communities can help them develop autonomy, a crucial element of networked learning environments. While earlier research, such as Zimmerman (2002), highlighted the importance of self-regulation, this article provides a more targeted application within the framework of connectivism.

4. Addressing Implementation Challenges: I identify several challenges to implementing connectivism principles, such as the digital divide, information overload, and the varying levels of digital literacy among students. It suggests that addressing these challenges requires systemic changes, including better access to technology, teacher training, and the development of critical thinking and digital skills. The issue of the digital divide was noted by Norris (2001), but the article expands on this by offering solutions, such as integrating low-cost digital tools and providing ongoing support to educators and students in under-resourced areas. Similarly, the problem of information overload, as discussed by Tsai & Ghoshal (1998), is tackled by promoting information literacy skills, enabling students to discern credible information from unreliable sources.

Relating the Findings to Previous Studies

The findings of the article build upon and extend previous studies on connectivism. Earlier works by Siemens (2005) and Downes (2010) laid the theoretical groundwork by proposing that knowledge is distributed across networks and that learning involves the ability to connect and navigate these networks. The current article takes this theory further by offering practical guidance on how to create educational environments that reflect these principles.

For instance, while Kop & Hill (2008) noted the need for more comprehensive frameworks to apply connectivism practically, the current article addresses this by suggesting specific pedagogical strategies. Similarly, where Bell (2011) and Dunaway (2011) discussed the role of digital tools in learning, the current article integrates these tools into a broader educational strategy, emphasizing not just the use of technology but the development of essential skills for networked learning.

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Moreover, the article's focus on project-based learning resonates with experiential learning theories by Kolb (1984) and collaborative learning approaches by Johnson & Johnson (2009). However, it expands on these by showing how digital tools can facilitate such learning experiences, making them more relevant to the digital age. The findings also align with Vygotsky's (1978) social learning theory and Wenger's (1998) communities of practice, but they are unique in emphasizing the digital aspect of these connections, illustrating how online platforms and social networks can extend traditional learning communities.

The summary of the findings and their relation to the previous study can be seen in the table.2.

Tablel 2. Summary of Findings

Key Strategy	Description	Connection to Previous Studies
Emphasis on Networked Learning and Digital Literacy	The article highlights the importance of forming and navigating networks of information as a core element of connectivism. Educators are encouraged to help students build personal learning networks, which include digital resources, experts, and peers. Digital literacy skills are essential, enabling students to navigate, filter, and assess information across platforms like Google Classroom and Virtual meeting platform. Collaborative projects are also suggested to develop these skills.	Reflects Siemens (2005) who emphasized the value of connecting information over mere knowledge accumulation. The article extends this by offering specific methods to teach digital literacy.
Practical Strategies for Implementation	Practical strategies such as Project-Based Learning (PBL) are discussed in detail. PBL allows students to apply theoretical knowledge to real-world problems, fostering critical thinking and collaboration. By integrating PBL tasks that require the use of digital tools, educators can create dynamic and engaging learning environments. The article offers concrete examples of how PBL can facilitate networked learning, addressing gaps noted in previous research that acknowledged the potential but lacked specifics.	Aligns with Kolb (1984) and Johnson & Johnson (2009) on learning through doing. Addresses the gaps noted by Dunaway (2011) and Bell (2011) by providing structured PBL examples.
Supporting Student Autonomy and Self-Regulation	The article emphasizes the need for students to be active participants in their learning, capable of self-regulation and critical thinking. Educators can cultivate these skills through scaffolding and guidance, encouraging self-directed projects and connections with online communities. This approach aligns with social learning theories but goes further by offering targeted methods for developing autonomy within a connectivist framework.	Builds on earlier theories by Vygotsky (1978) on social learning and Wenger (1998) on communities of practice. Expands on Zimmerman (2002) by applying self-regulation to connectivist contexts.
Addressing Implementation Challenges	The article identifies challenges such as the digital divide, information overload, and varying levels of digital literacy among students. To address these, systemic changes are recommended, including better access to technology, teacher training, and promoting critical thinking and digital skills. Solutions include integrating low-cost digital tools	Extends on the issue of the digital divide noted by Norris (2001) and tackles information overload as discussed by Tsai & Ghoshal (1998) by offering concrete strategies to address them.

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	and ongoing support for educators, as well as promoting information literacy to help students navigate information overload.

Discussion

The present study on the application of connectivism principles in modern education builds upon and extends the existing body of literature in several significant ways. This research corroborates many of the foundational concepts proposed by Siemens (2005) and Downes (2010), while also offering new insights into the practical implementation of connectivism approaches in diverse educational contexts.

The study's findings align closely with Siemens' (2005) original conceptualization of connectivism as a learning theory that recognizes the networked nature of knowledge in the digital age. The research reaffirms the importance of forming connections between information sources and the ability to navigate complex information landscapes, as emphasized in Siemens' work. Moreover, the study's focus on the role of technology in facilitating these connections echoes Downes' (2010) emphasis on the importance of digital tools in modern learning environments.

However, this research extends beyond theoretical foundations to explore practical applications, addressing a gap identified by Kop and Hill (2008), who noted the need for more exploration of connectivism's implications for teaching methodologies. The current study provides concrete strategies for implementing connectivism principles in classroom settings, offering valuable insights for educators seeking to adapt their practices to the demands of the digital age.

The research's findings on the importance of digital literacy and critical thinking skills in connectivism learning environments align with the work of Dunaway (2011), who emphasized these competencies as crucial for navigating networked information landscapes. However, the present study goes further by examining how these skills can be cultivated through specific pedagogical approaches, such as project-based learning and collaborative online activities.

In addressing the challenges of implementing connectivism approaches, this study builds upon the concerns raised by earlier researchers. For instance, the identified issues of technological access and the digital divide echo the findings of Norris (2001), while the challenges related to information overload and quality control align with observations made by Tsai and Ghoshal (1998). However, this research contributes to the field by proposing potential solutions and strategies to mitigate these challenges, offering a more optimistic outlook on the feasibility of connectivism education.

The study's exploration of the impact of connectivism approaches on student engagement and learning outcomes provides empirical support for the theoretical propositions of earlier researchers. The findings on enhanced cognitive engagement through networked learning and the development of problem-solving skills align with the work of Plaut (1995) and Khoshnevisan et al. (2014), respectively. However, this research offers a more comprehensive examination of these outcomes in the context of connectivism pedagogy.

A significant contribution of this study lies in its examination of connectivism within the Indonesian educational context. While previous research, such as that by Susanti and Rahayu (2020), has explored aspects of online learning in Indonesia, the present study provides a more holistic analysis of how connectivism principles can be integrated into the country's education system. This contextual application of connectivism theory adds valuable insights to the growing body of literature on educational approaches in diverse cultural settings.

The research also advances the discourse on the role of educators in connectivism learning environments. Building on the work of Salmon (2013) on online facilitation, this study offers a nuanced exploration of how teachers can transition from being primary knowledge disseminators to facilitators of networked learning. The findings highlight the need for ongoing professional development and the cultivation of new pedagogical skills among educators.

To sum up, the table 3 illustrates that the novelty of the current article lies in its practical approach to implementing connectivism principles, specific strategies for addressing challenges, and the integration of digital literacy and real-world applications. Unlike previous studies that were often theoretical or lacked concrete strategies, this article provides a structured framework that educators can adopt to transform traditional classrooms into dynamic, networked learning environments.

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Table 3. Comparison novelty and previous study

Aspect	Novelty in This Article	Previous Studies
Theoretical Foundation of Connectivism	Builds on the foundation by Siemens (2005) and Downes (2010), extending their theories into practical applications. Discusses how connectivism principles can be implemented in classrooms.	Siemens (2005): Introduced connectivism as a learning theory focusing on networks and connections. Downes (2010): Expanded on theoretical aspects, but did not provide practical guidance. Kop & Hill (2008): Highlighted the potential of connectivism but noted the lack of comprehensive frameworks for implementation.
Emphasis on Digital Literacy	Highlights digital literacy as a core component, focusing on skills to navigate, filter, and connect information using digital tools.	Transue (2013): Recognized the importance of digital tools but did not emphasize structured approaches to teaching digital literacy. Veletsianos (2011): Focused on emerging technologies without detailing the skills needed to use them effectively
Practical Implementation of Connectivism	Provides actionable strategies such as project-based learning (PBL), using digital platforms, and integrating real-world issues to create dynamic learning environments.	Bell (2011): Discussed the role of connectivism in technology-enabled learning but lacked specific pedagogical strategies. Dunaway (2011): Mentioned connecting various nodes of information but did not elaborate on practical methods.
Addressing Implementation Challenges	Discusses challenges such as the digital divide, information overload, and the need for self-regulation skills. Offers solutions like educator training and promoting critical thinking.	Tsai & Ghoshal (1998): Identified information overload but lacked specific educational interventions. Zimmerman (2002): Highlighted self-regulation in learning but did not connect it directly to connectivism.
Student Autonomy and Self-Directed Learning	Advocates for student-led learning with educators acting as facilitators, guiding students to build personal learning networks.	Vygotsky (1978): Discussed social aspects of learning but not in a digital context. Wenger (1998): Focused on communities of practice but did not address how to nurture student autonomy in a connectivist model.
Integration of Real-World Applications	Emphasizes integrating real-world issues into the curriculum to enhance student engagement, with examples like debates on renewable energy and project-based activities.	Kolb (1984): Supported experiential learning but did not connect it directly to digital or real-world applications in a connectivist framework. Johnson & Johnson (2009): Promoted collaborative learning, but lacked the focus on real-world digital integration seen in the current article.
Expanding the Educator's Role	Suggests educators should be facilitators, helping students navigate digital tools, assess information, and foster collaboration.	Salmon (2013): Discussed online teaching but did not emphasize the specific role of educators as facilitators in a connectivist model. Dron & Anderson (2014): Focused on online learning communities without detailing how teachers can adopt connectivism.
Lifelong Learning and Adaptability	Stresses the need for lifelong learning, adaptability, and the ability to learn, unlearn, and relearn. Provides strategies to cultivate these habits.	Lave & Wenger (1991): Described learning as a social process but did not explicitly address lifelong learning in a digital context. Granovetter (1973) & Coleman (1988): Explored networks in information sharing but did not connect these ideas to lifelong learning.
Use of Digital Platforms and MOOCs	Highlights the use of MOOCs and digital platforms to implement connectivist principles, enabling students to connect with global networks of learners.	Purwanto (2021): Discussed interdisciplinary studies and MOOCs but did not extend the concept to creating global learning networks in a connectivist sense.
Integration of Diverse Perspectives	Encourages exposure to diverse viewpoints to enrich learning, promoting critical thinking and nuanced understanding.	Siemens (2005): Mentioned the importance of diversity in opinions but did not provide practical steps to implement this in classrooms. Dunaway (2011): Acknowledged the need for diverse sources but without practical educational integration.
Focus on Adaptability of Information	Promotes skills for adapting to new information and continuous updating of knowledge, essential in the digital age.	Downes (2010): Highlighted the need for continual adaptation but did not offer specific educational strategies to develop this skill in students.

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Connection Between Formal and Informal Learning	Suggests bridging formal education with informal learning through digital platforms and online communities, enhancing students' learning networks.	Dron & Anderson (2014): Discussed informal online learning communities, but did not focus on connecting these with formal educational settings.
Overcoming the Digital Divide	Addresses digital access issues by suggesting methods to support under-resourced schools and providing ideas on educator training to integrate digital tools effectively.	Norris (2001): Discussed the digital divide but did not propose educational solutions.
Assessment and Evaluation	Highlights the need for new assessment methods to evaluate skills gained through connectivist learning, beyond traditional exams.	Anderson (2008): Noted challenges with traditional assessments in online learning but did not develop specific alternatives aligned with connectivism.

In conclusion, while this study reinforces many of the core principles of connectivism established by earlier researchers, it makes significant contributions to the field by providing practical insights into the implementation of these principles, exploring their impact on student learning, and examining their application in specific cultural contexts. The research addresses gaps in the existing literature and offers a forward-looking perspective on the potential of connectivism approaches to transform educational practices in the digital age. Future research may build upon these findings to further explore long-term outcomes of connectivism education and develop more refined strategies for overcoming the identified challenges in its implementation.

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