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Self-Directed Learning Strategies and Knowledge Construction of University Students: Achieving Learning Goals and Managing Cognitive Load

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Abstract: This study delved into the self-directed learning strategies employed by university students to construct knowledge and manage cognitive load, aiming to achieve their learning goals. Addressing a gap in understanding how students align these strategies with cognitive and motivational principles, the research aimed to investigate specific strategies and their effectiveness. The novelty of this research lies in its qualitative exploration within diverse educational contexts, contributing practical frameworks for integrating self-directed learning (SDL) with knowledge construction. Employing a qualitative methodology, the study involved interviews with 10 university students from various disciplines to uncover their learning strategies and cognitive load management techniques. Results indicated that students commonly utilized task prioritization, content organization tools, and collaborative discussions for knowledge construction, while managing cognitive load through task breakdown, rest periods, and focus on essential material. Digital platforms and interactive media emerged as critical tools in SDL. In summary, this study selects appropriate SDL strategies for learners, enhances their learning goals, and promotes the implementation of SDG4.

Keywords: Constructivism, Self-Directed Learning, Cognitive Development Cognitive Load, Knowledge Construction.

1. Introduction

Modern educational trends highlight the importance of self-directed learning (SDL), where learners take ownership of their knowledge acquisition. In constructivist theory, knowledge construction requires deeper understanding and application through active engagement with information. The shift from traditional teaching to learner-centered approaches emphasizes the autonomy to manage learning goals, but achieving these goals depends on strategies for knowledge construction and cognitive load management. Despite existing research on constructivist learning, gaps remain in understanding how learners select effective SDL strategies to address these elements. This is especially critical for college students in diverse educational settings and aligns with promoting SDG4 for quality education.

Knowledge construction is a dynamic process involving active participation, cognitive reconstruction, and reflection. College students often navigate this process independently within their cognitive limits and motivation levels. This paper explores the compatibility between SDL strategies and knowledge construction principles from a constructivist perspective, integrating theories of Cognitive Development, Constructive Processes, and Cognitive Load. By examining the efficiency and effectiveness of these processes, the study aims to provide theoretical support for optimizing SDL strategies, helping students achieve learning goals while contributing to the dissemination and development of quality education.

1.1. Research objectives

To find out how university students utilize self-directed learning strategies to construct knowledge and manage cognitive load effectively in order to achieve their learning goals.

2. Literature Review

For the purpose of efficiently constructing knowledge, which is essential for both their academic performance and their personal development, university students apply a variety of different ways for independent learning. Self-directed learning (SDL), metacognitive practices, and the regulation of cognitive load are all included in these tactics. Each of these strategies contributes to a more profound comprehension of the subject matter and improves the outcomes of learning.

Students take the initiative in the educational process, including setting learning goals, selecting materials, and evaluating their progress. This is the defining characteristic of self-directed learning, which is characterised by autonomous learning. One study, for instance, found that nursing students who engaged in blended learning environments displayed significant increases in self-directed learning skills, which in turn boosted their readiness for lifelong learning (Govindan et al., 2023). This was one of the findings of the study. It would appear from this that the development of SDL not only adds to the accumulation of knowledge, but also helps students get ready for the obstacles they will face in their future employment.

Metacognitive strategies play a crucial role in self-directed learning by enabling students to reflect on their learning process, assess their understanding, and adjust their strategies accordingly. Effective metacognitive practices include self-monitoring and self-regulation, which are essential for managing cognitive load during learning activities (Shin & Song, 2022; Händel et al., 2020). For instance, students who have training in self-regulatory learning strategies can manage their cognitive loads better because they are more aware of how much extra time and resources they would need to invest to accomplish a certain task with optimum learning effectiveness (Shin & Song, 2022). This is particularly important in many demanding cognitive environments, such

as those found in inquiry-based learning, by Kadir et al. (2023).

Collaborative learning enhances knowledge building by allowing students to engage in dialog and share ideas with their peers. This interaction promotes critical thinking and the development of new ideas as students challenge and refine each other's understanding (Castro & Zermeño, 2021). Studies have shown that collaborative learning environments (e.g., learning environments supported by cloud-based tools) have a positive impact on students' cognitive engagement and knowledge sharing, leading to a deeper learning experience ("Knowledge of HIV/AIDS and its Determinants among Students at Assiut University, Egypt," 2019). In addition, the integration of e-portfolios as a collaborative learning tool has been shown to support students' constructive efforts in knowledge acquisition, enabling them to reflect on their learning journey (Naif et al., 2019).

Also, managing cognitive load is part and parcel of the learning process due to the direct relation it has on the ability of the student in processing and retaining information. According to CLT, learning is most efficient when resources are put to use in the most efficient way possible to reduce irrelevant loads while increasing germane and relevant loads (Choi & Kim, 2021; Zhu, 2022). These techniques, like reduced load instruction, can help students with cognitive load management more effectively. For instance, students may experience a reduction in the level of cognitive burden from an instructional design that includes multimedia elements and interactive simulations; therefore, engaging students in such activities could result in more meaningful learning of complex concepts (Partarakis, 2023).

Research proves that students strategically handle the cognitive load, especially in a computationally complex learning environment, such as simulation-based education. For instance, one recent study proved that when the complexity of the task is increased, students employ their strategies that help them manage intrinsic cognitive load and work effectively while learning relevant material (Tremblay et al., 2022; Atiomo, 2024). This self-management is crucial as too much cognitive load can hinder the achievement of learning goals and impede cognitive development (Costley, 2020). Furthermore, by reducing unnecessary cognitive load, students' affective engagement is enhanced, leading to greater enjoyment and immersion in the learning activity, thus optimizing knowledge acquisition (Martin et al., 2021).

Various specific self-directed learning strategies can also further reduce the cognitive load. Studies suggest that information chunking and gamified learning environments will influence students' attitudes toward learning positively and induce cognitive absorption (Topu, 2023; Putri et al., 2022). On the other hand, there are microlearning strategies that have been developed to reduce cognitive load in online environments, thus allowing students to engage the material flexibly in pace with their level of readiness to learn (Susilana et al., 2022). Besides reducing cognitive load, microlearning strategies can create opportunities for deeper engagement with the learning material, which is an excellent avenue to better educational outcomes.

Integration of cognitive load theory and self-regulated learning strategies has also been a desirable area for further research. In this respect, understanding the dynamic relationship between cognitive resources and learning processes helps educators to produce instructional materials and environments that better support students in managing their cognitive load (Ouwehand et al., 2021; Castro-Alonso et al., 2021). For instance, LRI may provide an effective management of cognitive load in inquiry-based learning settings, thereby enhancing student approaches to learning and achievement, as suggested by Kadir et al. (2023).

To summarise, college students employ a wide range of self-directed learning practices in order to effectively create their knowledge. Through the implementation of self-directed learning, the adoption of metacognitive techniques, and the management of cognitive load, students have the ability to improve their learning experience and accomplish their academic objectives.

2.1. Theory Underpinning

2.1.1. Cognitive Development - Knowledge Construction

Cognitive development is central to knowledge construction in that it involves the processes through which students acquire, organize, and use information. Students enact SDL through taking responsibility for one's learning, which maintains deeper cognitive engagement and heightens the ability of students to construct knowledge (Mutiaraningrum & Nugroho, 2020). Research has shown that students develop higher-order thinking to effectively construct knowledge when they are active participants in the process, such as through discussion, reflection, and problem-solving activities. For instance, during synchronous text-based discussions, learners are not only able to build on each other's information, but they also practice critical thinking and collaborate on knowledge development important for cognitive development (Mutiaraningrum & Nugroho, 2020).

2.1.2. Constructive Processes - Knowledge Construction

Constructive processes are integral to how students build knowledge. Constructivism posits that learners actively construct their understanding through experiences and interactions with their environment (Lau et al., 2022). Vuopala et al. emphasize that interaction among learners is a key factor in knowledge co-construction, where learners build new knowledge through their interactions (Vuopala et al., 2019). This is mirrored by Almodiel, who also states that online discussion forums give learners an opportunity to engage in meaningful interactions that enhance knowledge construction (Almodiel, 2022). The interactions can be facilitated by a social network; this is also clarified by how social interactions within learning groups lead to cognitive growth and knowledge integration (Xue et al., 2020).

2.1.3. Metacognition - Knowledge Construction

Teng et al. (2021) provide empirical evidence supporting the notion that metacognitive strategies significantly correlate with academic writing performance in foreign language contexts. Their findings suggest that metacognition serves as a systematic structure of knowledge that can predict a range of learning strategies, thereby facilitating effective academic writing practices (Teng et al., 2021). This aligns with the work of Riwayatiningsih et al. (2021), who argue that teachers' metacognitive knowledge is essential for promoting critical thinking among English as a Foreign Language (EFL) learners.

2.1.4. Cognitive Load Theory - Knowledge Construction

Cognitive Load Theory provides a basis in which students can try to manage their cognitive resources during learning. CLT distinguishes between three types of cognitive load: intrinsic, extraneous, and germane. Lin et al. (2023) examine how collaborative cognitive load theory can enhance

augmented reality learning efficiency through reduced cognitive load induced by the collaborative behaviors of students. This is also in line with the concept that good collaboration may decrease the burdens of information processing to a level at which it does not impede the ease of learning. Lin et al. (2023) Barile et al. (2022) examine the usage of virtual learning environments and its effects on the cognitive load of students, indicating that properly organized learning resources could lead to better academic performance by optimizing cognitive engagement. This is of especial relevance in online learning, where the cognitive load significantly depends on how educational materials are designed and delivered (Barile et al., 2022).Thorpe's findings suggest that aligning learning resources with students' cognitive abilities could help minimize extraneous cognitive load for better learning outcomes (Thorpe, 2023).

2.1.5. Motivation - Knowledge Construction

Motivation is one of the decisive elements that affect learners' self-directed learning and knowledge construction. Indeed, motivated learners are likely to show self-initiated learning activities, challenge themselves with ambitious goals, and resolve possible obstacles (Wulandari & Anugerahwati, 2021). Constructive criticism can be a motivational tool since students get specific feedback that enhances their performance and encourages their further learning process (Susilana & Pribadi, 2021). Additionally, fostering a supportive learning environment that promotes autonomy and competence can significantly boost students' intrinsic motivation, leading to more effective knowledge construction (Perkowska-Klejman, 2023).

These findings foreground different ways university students tend to mobilize from their repertoire of self-directed learning strategy to develop knowledge and manage cognitive load. If students are to help themselves through cognitive development, constructive processes, metacognition, cognitive load theory, and motivation, then there is a need for learning to be developed that assists them to get to their academic goals.

2.2. Research Gap

The research gap in this study focuses on how college students employ self-directed learning strategies when effectively constructing knowledge and managing cognitive load. While there is considerable literature on constructivism and SDL, there is a significant gap in the understanding of how learners merge these strategies with cognitive and motivational principles to enhance learning processes. The study, therefore, tries to fill this gap by investigating the types of SDL strategies that students employ and their effectiveness in knowledge construction and impacts on the management of cognitive load. On the other hand, it tries to give substantial theoretical support for a practical integration between SDL and knowledge construction principles, which is relatively scant in the literature, especially with regard to different educational settings. The study will therefore contribute to providing a theoretical basis for optimizing SDL strategies that facilitate university students in achieving learning goals effectively and advance the realization of SDG4 through these efforts.

3. Methodology: The Main Process of the Main Study

This study employed a qualitative approach through questions similar to the research objectives using oral or online interviews. This approach has been used in this study for the purpose of gaining a comprehensive understanding of how college students choose between different learning strategies and construct information while engaging in self-directed learning. The qualitative method is befitting for educational research because it aids in understanding the personal experiences and perspectives of students, and it helps to uncover valuable insights from their narratives. Qualitative methods are particularly effective in exploring complex cognitive and behavioural phenomena; they allow the collection of rich, nuanced data.

3.1. Sampling and Participants

This research project included a total of ten participants, all of whom were students at a university, and they came from a variety of academic fields, levels of education, and different types of educational backgrounds. All of the participants communicated with the researcher through verbal or online interviews, which allowed the researcher to record verbal and non-verbal cues such as intonation, tone, and expression from the participants in order to enrich the data. This technique guaranteed that a comprehensive investigation of the students' experiences of self-directed learning and knowledge production was carried out, while simultaneously preserving a qualitative approach that was consistent throughout.

3.2. Research Instruments

Research Objective : To find out how university students utilize self-directed learning strategies to construct knowledge and manage cognitive load effectively in order to achieve their learning goals.

Interview questions:

i)How do you use self-directed learning strategies to construct knowledge and manage cognitive load in achieving your learning goals?

Sub-question 1:What methods or strategies do you usually use to actively understand and construct new knowledge? Please specify how these methods helped you to achieve your learning objectives.

Sub-question 2:What resources or tools (e.g., online courses, scholarly articles, or discussion groups) have been most helpful to you in constructing knowledge during self-directed learning? How did you use them?

Sub-question 3:What strategies do you use to plan your learning activities? Do they help you achieve your learning goals?

Sub-question 4:How do you handle situations where you feel overwhelmed with information or tasks?

Sub-question 5: What strategies do you use to simplify or break down difficult tasks?

3.3. Data Collection Methods

The study participants were undergraduates from a variety of disciplines who were carefully selected to ensure a diverse sample representing different learning styles and educational backgrounds. Participants were selected based on the following criteria: first, they had to be actively engaged in self-directed learning as part of their learning routine. In addition, they needed to have a clear understanding of their learning goals and be willing to share their experiences and knowledge building strategies.

The interviews were conducted both verbally and online, and participants from diverse linguistic backgrounds were

ensured to participate by distributing invitations to the interviews with language options that were familiar to the participants. This approach encouraged participants to express themselves fully and comfortably and ensured that rich, detailed qualitative data was collected.

In this context, the researcher applied an interview structure with fixed and open-ended questions to support students in discussing strategies of self-directed learning and obstacles. The researcher audio-recorded the interviews with participants' consent, which were later transcribed verbatim for analysis. During the interviews, the researcher also made handwritten notes that included non-verbal information and contextual subtlety, both of which enhanced the meaning of participants' opinions and views.

Table 1. Presents comprehensive demographic and academic details of the participants.

	Gender	Subject	Common Knowledge Construction Strategies	Common Cognitive Load Management Strategies	Common resources/tools
1	Female	Education	Summary notes, mind maps	Prioritizing tasks, using Pomodoro Timer	Google Scholar, Chaoxing Learning App, group discussions
2	Male	Engineering	Practice questions, reviewing textbooks	Taking breaks, reorganizing tasks	Tencent Classroom
3	Male	Economics	Watching instructional videos	Completing tasks in phases	Academic articles, group discussions
4	Female	Computer Science	Preview and Review	Tackle tasks in stages and take breaks	Super Star Learning, academic articles, online discussion groups
5	Male	Psychology	Reading textbooks,Group disscussions	Reprioritize and deconstruct tasks	Tencent Classroom, CNKI
6	Female	Data Science	Feynman learning method, R language practice	Mind mapping, filtering core content	Coursera, academic articles
7	Male	Law	Restating knowledge, case studies	Organizing information with mind maps, focusing on core tasks	Online courses, academic articles
8	Female	Mathematics	Spaced repetition, organizing knowledge frameworks	Breaking tasks into smaller parts, gradual completion	Online courses, academic articles, discussion groups
9	Female	Business	Flowcharts, role-playing techniques	Listing and prioritizing tasks, categorizing information	Reddit, Google Scholar
10	Male	Biology	Systematic explanation, case analysis	Modular task handling, referencing similar cases	YouTube, interactive online courses

3.4. Confidentiality and Ethical Considerations

3.4.1. Confidentiality

In this study, the following measures were taken to strictly protect the privacy of the compliant participants and to comply with other confidentiality requirements of the participants:

Personal information: All participants' identifying information will be anonymized. Nothing will be used in the data collection, storage and reporting process that could lead to the identification of participants' personal information. Participants will be numbered to ensure information protection.

Data storage: All study data (including audio recordings of interviews, transcribed documents/questionnaire back-end data, and notes) will be stored on encrypted devices or in the cloud and will only be accessible by unanimous consent of the study team.

Confidentiality of results: The results of the study will be presented in the form of summarized data, only numbers and figures will appear, and no details revealing personal information will appear.

3.4.2. Ethical Considerations

The researchers ensured that all participants gave their voluntary consent by providing them with an informed consent form. This questionnaire and the correspondence chat logs were evidence that the participants were aware of the objectives and uses of the study. This was done to maintain ethical standards throughout the study. Furthermore, the researchers assured the participants that they could withdraw from the study at any time without any negative consequences and provided them with clear information about the voluntary nature of their participation in the study.

4. Results

4.1. Effective Strategies for Knowledge Construction Through Organization, Application, and Interaction.

Participants presented various ways of building knowledge, including organization of content, practical application, and

interaction to build knowledge. Most of the students synthesized information and connected concepts with the help of mind maps, flowcharts, and summary notes, as Respondent 1 noted: "Mind mapping helps me connect the dots between different ideas, making revision easier and more structured." Others focused on the application of theoretical knowledge to practical cases, such as projects or case analysis, with Respondent 6 sharing the Feynman technique to crystallize understanding by teaching others. Discussions in study groups or online forums were also a strong point, since, as Respondent 3 maintained, "Discussion among peers often uncovers viewpoints I hadn't ever considered." All these methods combined to more meaningful comprehension and an improved construction of knowledge.

4.2. Strategies for Managing Cognitive Load in Self-Directed Learning.

Managing cognitive load became a significant issue that participants dealt with in effective SDL by task prioritizing, resting and recovering, and filtering resources. The respondents also stressed listing tasks and ranking them based on urgency and difficulty. As Respondent 8 put it, "Breaking down tasks into smaller chunks helps me focus better and reduces stress." Students avoided the prospect of cognitive overload using strategies such as the Pomodoro method or other frequent breaks. According to Respondent 5, "Taking short breaks after completing smaller tasks helps refresh my mind." Many participants also focused on core content while striving to avoid extraneous information. As noted by Respondent 10, "I try to focus on essential material, skipping unnecessary details." These strategies, among others, were how students tried to manage their cognitive resources effectively during SDL.

4.3. Enhancing Self-Directed Learning Through Digital and Collaborative Resources.

Students emphasized how using digital and academic resources assists them in the SDL.Participants emphasized how resource and tool support for their SDL can come in the form of digital platforms, interactive media, and collaboration spaces. Tools like Coursera, Google Scholar, and Super Star Learning have been repeatedly mentioned to get access to structured content: "Platforms like Coursera offer lessons that are well-structured and fit my learning pace," noted Respondent 7. The utilization of multimedia resources also extended to guided videos and game-like learning environments that helped increase engagement: Respondent 9 highlighted how YouTube tutorials made it easier to comprehend hard concepts. Online and offline discussion groups also allow the opportunity for information exchange and multiple perspectives; for instance, Respondent 4 expressed, "Group discussions not only help me clarify doubts but also expose me to diverse viewpoints." These resources together have contributed much toward improving the SDL experience of students.

4.4. Sustaining Motivation Through Goal-Setting and Feedback in Self-Directed Learning.

Motivation was a very important factor that maintained students' SDL efforts. Participants identified goal-setting and constructive feedback as two of the most helpful ways to maintain motivation in SDL. Setting specific, achievable goals was also an effective strategy to remain focused on one's work, as Respondent 2 stated, "Having clear objectives keeps me on track and motivated." Moreover, peer and instructor feedback was quite helpful to improve performance and to put in more effort, as Respondent 6 pointed out, "Constructive feedback from peers helped to refine understanding and approach." Motivational factors like these helped students remain committed to engagement and progress on their learning journeys.

4.5. Overcoming Challenges Through Task Simplification and Support Networks.

Respondents had to overcome such challenges as information overload and problems with effective time management, but the respondents developed strategies to overcome these issues. The majority of the respondents regularly broke down complex tasks into simpler ones to maintain stable achievements: "Breaking tasks into smaller parts reduces the overwhelming feeling," according to Respondent 8. Another source of intellectual and moral support in hard times was contact with peer or mentor support networks. "Stuck, I ask my colleagues or professors for advice, which always helps a lot," said the fifth respondent. It was with the help of such strategies that students could work out obstacles and stay on track toward the realization of learning goals.

The findings suggest that university students employ a range of SDL strategies that align with constructivist principles and cognitive load theory. These strategies include structured planning, resource optimization, and the application of interactive and motivational tools to facilitate knowledge construction and manage cognitive load. The diverse approaches reflect the adaptability of SDL to meet individual learning goals and highlight its potential to support educational frameworks aligned with SDG4 objectives.

5. Discussion

This study therefore shows that university students use multiple self-directed learning strategies to efficiently construct knowledge and control the complexity of, or overload on, working memory. More specifically, the main strategies were organizing of the content through the use of mind maps and flowcharts, application of theoretical knowledge in practical situations, and discussion with co-learners. Cognitive load was managed by prioritizing tasks, taking scheduled breaks, and filtering the most important content to reduce extraneous load. Furthermore, digital platforms and interactive media, including discussion groups, have greatly supported structured content access, as well as collaboration with peers. These results confirm previous studies on structuring learning processes, handling cognitive demands, and creating engaging learning environments, all contributing significantly to the students' learning achievement.

The present study has brought out the interrelationship of self-directed learning strategies and cognitive load theory in providing new insights into optimizing educational practices. Using constructivist principles, like active processing of information and managing knowledge structures, students could enhance efficiency in learning. The amalgamation of motivation and resourceful management of cognitive challenges further fortifies the holistic approach to SDL.

These findings contribute to the closing of this gap by showing that cognitive load theory practically agrees with SDL strategies in natural classroom settings, hence providing evidence-based recommendations for designing personalized learning interventions. This will no doubt enable educators to create a more adaptable and supportive learning environment, furthering the goals of quality education under SDG4.

6. Conclusion

The research problem guiding this paper was set out to explain how university students deploy strategies of self-directed learning to construct knowledge and manage cognitive load adequately to reach their learning goals. The study examined the alignment of these strategies with principles of knowledge construction and cognitive load management.

These findings indicate that students use multiple tactics, including content organization, practical application of methods, and collaboration through discussions to enhance knowledge construction. This makes one limit the tasks, take breaks, and filter out information to maintain a good cognitive load. More importantly, motivation and digital tool use are useful to hold and optimize learning gains. Altogether, these strategies empower students to manage the challenges of independent learning and reach their academic goals.

This study, in a nutshell, points to the necessity of integrating structured, personalized learning strategies that account both for the cognitive and motivational aspects. Educators and institutions should focus on creating supportive learning environments that incorporate these strategies, enabling students to build knowledge effectively and manage cognitive resources. This would contribute to the bigger aim of enhancing quality education, fitting into global educational priorities.

7. Limitations and Future Research

There are several limitations in this study: the ten cases focusing on college students only, the small sample size, and dependence upon self-reported data of these students. Besides, there is a possibility that the study may not represent or reflect the complexity of the students' learning experiences correctly. Future research should include larger, more diverse samples. They rely on interviews, and there is a potential for bias in reporting since students might not fully declare their learning encounters or tactics. The participants came from a wide range of academic backgrounds; however, they did not delve into the issues and techniques that are special to their respective disciplines. Due to the fact that this research was done within a specific cultural and educational context, its applicability is likely to be limited to a number of different territories or educational systems.

Recommendations for future research: future research should incorporate a larger range of statistical data in order to assess the relevance of the findings to a variety of various demographics and cultural contexts. Validation and generalisation of the findings can be accomplished by the use of quantitative methods such as surveys or experimental research. Personalised approaches to knowledge acquisition in a variety of fields can be uncovered through the application of discipline-specific focused research. Future research can build on this foundation to further improve our understanding of self-directed learning strategies and knowledge production among college students. This can be accomplished by resolving the limitations of the study and expanding the scope of the research.

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