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Digital information literacy, self-directed learning, and personal knowledge management in critical readers: Application of IDC Theory

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Abstract

The usefulness of self-directed learning ability in education has been demonstrated in previous studies. However, there has been much less understanding of the importance of digital information literacy, as well as how to manage these abilities and knowledge, and their effects on learning processes, especially in the current situation of digital education dominance and the necessity of interest creation in students. In order to address such needs and to evaluate students, as well as determine the effectiveness of the Interest-Driven Creator (IDC) loops, this study was conducted. In this study, 164 English language students were asked to participate in the pre-test, treatment, and post-test processes, while the treatments for the IDC group were developed in the form of interest-creation-habit triple loops. The results represented that IDC hybrid instruction was more effective in strengthening digital information literacy and personal knowledge management; and the IDC hybrid group outperformed the non-IDC hybrid group in terms of self-directed learning skills. These findings also revealed that to develop self-directed learning in critical readers, in addition to digital skills and how to manage and apply acquired knowledge, learning instructions (i.e., interest-creation-habit loops) have been effective. The IDC-hybrid group also identified the features of participation, perception-interest and facility-opportunity as the most significant and tangible ones.

Keywords: Digital literacy, Critical reading, Personal knowledge management, Self-directed learning, IDC Theory

Introduction

Today, in the age of communication and information technology, knowledge can be called the basic power, the factor of differentiation, and the main capital of the life of individuals,

organizations, and social groups. Knowledge, according to many pioneers and researchers, is a pliable compound of experiences, values, background information, skills, and opinions that are used to gather and evaluate new practices and information (Eskiler et al., 2011). According to Wong et al. (2019), educational institutions and schools should focus on teaching methods and processes for acquiring and evolving the century skills, including self-directed learning (SDL), which has been introduced as a determinant skill in the present century. Self-directed learning is expounded as a learning process that involves setting an objective, planning, adapting, and using information or resources, and finally, appraising the whole process. There is a growing call for students to develop SDL capability following the shift from traditional teacher-centered classroom management to learning-oriented approaches and the pervasion of advanced educational technologies (Wong et al., 2019).

Meanwhile, Davis (2013) considered comprehension as the most basic element of any field of education, especially in the present age, where information affects many aspects of individuals' personal and social lives. In such situations, knowing how to read, identify components, and analyze the information contained in texts and understanding them, are acute needs for life which is the practical definition of critical reading (Alshaye, 2021; Wilson, 2016). A reading task in which a reader discusses, references, inductive reasoning, deductive reasoning, decision-making, and so on. Today, a learner is faced with different types of readable texts that, in order to understand the content, require interaction with the texts and their components and management of the information provided in them. Wichadee (2011) stated that most students need to act independently to further develop their informational needs. In this regard, Hiemstra (1994) has pointed out that in order for learners to reach a higher level of self-directedness throughout their lives, they have to be able to cope with the sheer amount of information available to them. In andragogy, SDL learning in grown-ups is a process based on the active participation of individuals, with or without the assistance of others, identifying their advancing necessities, determining objectives and making decisions, prioritizing their learning strategies, and assessing results (Henschke, 2016). It can be understood that this type of learning is like going through the transformational learning steps in which deep, constructive and meaningful learning matures in practices of critical reflections towards learning tasks such as reading. In this regard, Wilson (2016) emphasized that critical reading is still a very central and influential topic for learners since they are faced with a lot of reading material in which there is a variety of data and information; it is essential for them to be able to analyze and manage the provided information, strive for more personalized learning, and also create knowledge.

Therefore, this study was designed to investigate the effects of self-directed learning and digital information literacy (DIL) on personal knowledge management (PKM) in critical readers. This noble study is dedicated to the comparison of the effects of two independent

variables (SDL and DIL) on critical readers' PKM in two groups of IDC-hybrid learning and non-IDC blended learning to investigate the effectiveness of these instructional methods; and whether the trainings have made any difference between the SDL and DIL in both groups. In addition, this scrutiny sought to inquire about the correlation between SDL, DIL, and PKM.

Literature review

Digital information literacy

Literacy was portrayed as the capacity to read, write, and compute to communicate and perform tasks that many individuals think of as fundamentals for their daily life (Le & Le, 2007). As indicated by Greenberg et al. (2007), literacy is described as the capacity to use a variety of content, including readable and written, to work in the public arena, accomplish one's objectives and improve individuals' information and potential. These days, learning processes are a central theme of new literacy perspectives attributed to 21st-century technology-based skills (Le & Le, 2007). Digital literacy (DL), according to Greenberg et al. (2007), is the ability to use technology integrated facilities and tools with printed or written content to be used in the field of cultural development, awareness-raising, and knowledge sharing. According to Widanana (2019), DL refers to the ability to use and create technology-driven content, which includes detecting and sharing information, responding to inquiries and questions and interrelating with others using digital facilities. Widanana (2019) believes that the development of DL increases the ability to process various information and communicate effectively with others, as well as understanding how to use technology to achieve the desired objectives. He emphasizes that such literacy also involves awareness and critical thinking in individuals about the various effects of using technology in daily life. Buckingham (2015) stated that DL refers to a set of defined competencies in a wide range of fields that together demonstrate DL, and this is much more than a basic acquaintance with how technology is used.

In a discussion of the various concepts associated with DIL, this can be inferred from Cordell's (2013) study that information literacy (i.e., identifying the target database, determining the exact terms to be searched, selecting limiters, effectively evaluating the information found, etc.) and DL (how to browse library websites, access advanced search pages, save or upload or export texts' files or quotes, etc.) are interrelated (American Library Association, 2013). In another view, as Botturi (2019) acknowledged, the rapid development of digital technologies in recent years has led researchers to revise definitions and concepts related to information literacy to focus more on the effectiveness and efficiency of technologies (i.e., DIL). It was also emphasized that the new concept included various literacies including basic literacy (reading, writing, computation) as well as

computer literacy and media literacy; today, with the expansion of Internet access and social media, this concept is reflected in the form of digital media literacy (DML).

Given that in this study, the implementation of critical reading (CR) tasks in a digital learning environment was considered, therefore, it can be said that the main focus was on the usage of DIL in analyzing a text and finding answers to questions. Therefore, DIL in this study is defined as a set of capabilities to identify, understand, organize, and use digital information available in a variety of formats accessible through diverse digital resources. Moreover, in a comprehensive review of the components and concepts of DIL, one can refer to the two main frameworks proposed by Open University (followed by Dundee University) and the European framework (known as Dig-Camp). The first one focuses on factors of understanding and engaging in digital practices, finding information, evaluating information, communicating information, collaborating, and sharing information (Jackson & Greenhill, 2016) while the last one put more emphasis on data proficiency and information literacy, correspondence, and collaboration, advanced content creation, security and problem-solving (Carretero et al., 2017).

Personal knowledge management

The concept of knowledge management (KM) in the beginning has been mainly related to organizational approaches that focus on aspects of knowledge creation, transfer, and presentation in organizations in a way that a wide range of KM research concentrates on knowledge transformation in individuals' minds is transferred, expanded, managed, and exploited across organizations (Rechberg & Syed, 2012). However, scant attention has been paid to knowledge formation and synthesization at the individual level (Pauleen & Gorman, 2016) and as it was mentioned by Jarrahi et al. (2019), such attitude remains in studies based on which the main focus is on organizations, not its thoughtful constituents (i.e., individuals). In recent years, with the advancement of the concept of personal KM (PKM), an emerging stream of research has begun in this area that focuses on how knowledge is acquired, applied, and developed in individuals (Hwang et al., 2018).

In the search for the definition of knowledge, various aspects have been considered, most of which have consented that knowledge is a coordinated arrangement of thoughts, procedures, and data (Bhatt, 2000). Dei and van der Walt (2020) define it as a dynamic blend of outlined insights, values, relevant data, and elites' visions that provides a systematic procedure for assessing and consolidating new experiences and data. That is, knowledge accompanies understanding; such cognizance assists with the recognition of various kinds of knowledge: tacit and explicit. The first one, the knowledge of how to do or intuitive knowledge is based on personal practice, internalization, and experience and is rarely expressed openly and is often similar to intuition (Horvath, 2001); this type of knowledge is acquired through socialization and interaction with individuals or groups.

While the last one is the knowledge of what (Gonzalez & Martins, 2017), or codified knowledge, archived, processed, and protected by information systems (Yeh, 2012). Litvaj et al. (2022) acknowledge that the basis of personal and administrative decisions is the knowledge that is widely available nowadays to people through a variety of methods. They emphasize that what is very important now is to know how to use all this knowledge (i.e., knowledge management). The concept of the PKM, according to Dorsey (2000), refers to the set of processes that result in information creation. He also introduced the set of skills required to meet the challenges of the information society, including information retrieval, evaluation, organization, analysis, presentation, security, and sharing information. In this study, PKM is seen as the management of the processes of gathering, creating, storing, disseminating, and utilizing knowledge in the presence of technologies and in order to provide the most efficient methods of learning and decision-making (critical thinking) in readers.

Self-directed learning

The concept of self-directed learning (SDL) has been introduced to the world for decades. According to Williamson (2007), SDL is a learning process in which students are liable for arranging, executing, and assessing their learning; when striving to achieve their predetermined learning goals independently or in interaction with others. They stated that SDL first acquires an experimental environment and then evolves in the curriculum, which indicates the importance of paying attention to it and introducing its skills in the curriculum. In studying SDL, Candy (1991) emphasized four dimensions of personal autonomy, self-administration, self-control, and self-learning, while Williamson (2007) focused on self-direction and lifelong learning. Williamson (2007) introduced awareness (i.e., understanding people about the factors affecting the development of self-directed learning), learning strategies (i.e., strategies that people adopt to develop self-directed learning), learning activities (i.e., learning activities required in the development of active and self-directed learning), evaluation (i.e., features and skills needed to monitor learning activities), and interpersonal skills (i.e., interpersonal communication skills that are a prerequisite for the development of self-directed learners) as the most determinant factors of SDL.

Today, with the widespread development of technologies, the need to pay attention to previous concepts from a new perspective is felt, especially in the field of education (Tekkol & Demireal, 2018). Rashid and Asghar (2016) observed that technology use was straightforwardly and decidedly connected with learners' engagement and their SDL level, the two of which were related to academic achievements. In this regard, Uz and Uzun (2018) represent that the use of technology is very effective in developing SDL, especially in the form of blended learning. However, despite the diversity and breadth of studies on SDL development in higher education and adulthood, few studies have focused on the impact of

SDL competencies on individual knowledge management and its application to critical reading. In this study, SDL refers to the process of applying a set of skills and abilities necessary for educational goal setting, planning, information retrieval, learning, and achieving predetermined objectives.

Digital information literacy, personal knowledge management, and self-directed learning in critical readers

Contrary to what the first wave of KM systems focused on, namely the organizational dimensions of knowledge management, the PKM seeks to align information values along with individuals' modern needs and social objectives (Razmerita et al., 2014). While much research has been done on the old approach, the number of studies on the new approach is very limited (Pauleen & Gorman, 2016). In this regard, Cigognini et al. (2011) presented one of the broadest skills frameworks required for PKM, in which its set of skills is divided into basic skills (creation, organization, and sharing) and high-level skills (connectedness, ability to balance formal and informal context, critical ability and creativity). According to Hwang et al. (2018), Pauleen and Gorman (2016), and Razmerita et al. (2009), PKM focuses on how to utilize and inquire about knowledge and information in individuals. Thus, as they pointed out, it refers to the cyclic methods used to make decisions and seek information, create knowledge, and earn experience. Jarrahi et al. (2019) acknowledged that PKM uses bottom-up knowledge practices, which leads to the continuous completion and evolution of personal knowledge; that is understood by Fujita (2020) as an example of self-directed learning and self-regulated learning. Hsiao and Huang (2019) and Silamut and Petsangsry (2020) emphasize the students' need to interact with others or peer groups through various learning technologies and social networks in order to receive feedback and share a variety of information in the tacit knowledge management phase. While in the explicit knowledge management phase, they need to generate, reserve, transform and manipulate, and utilize explicit knowledge to solve the problems (Lee, 2009). Anand and Singh (2011) also emphasized that students must figure out how to transform tacit knowledge into explicit one and apply both appropriately in real-life situations.

According to Indrašiene et al. (2021), knowledge management and critical thinking share the three basic areas of relationship, process, and objective. They also emphasize that the fundamental similarity in the processes of these two comprehensive concepts is in the continuous and gradual processing of information. They declare that, on one hand, knowledge is essential for critical thinking tasks of analyzing, questioning, interpreting, recreating, synthesizing, reflecting, evaluating, and explaining since one thinks based on the received content, not abstractly (Tiruneh et al., 2016). And on the other hand, knowledge itself is of little value as accumulated capital, but the point is knowing how to use it. Raudeliūnienė and Račinskaja (2014) and Brix (2017) stated that the knowledge

used by an individual is the basis for converting data into information and creating more value in solving problems and forming, evaluating, making, and implementing decisions. In this regard, Silamut and Petsangsri (2020) proposed an SDL and KM model to revamp DL.

Moreover, reading is the process of studying content, recognizing its components, analyzing its elements, distinguishing the author's voice, and understanding its meaning and message - which in practice is critical reading (Heidari, 2020; Majumdar et al, 2021). They state that such activity requires higher levels of cognitive abilities such as comprehension, analysis, evaluation, interpretation, and synthesis of information presented in the text. This concept is consistent with the definition of critical reading in this study in which such activity requires highlighting important ideas in the text, recognizing the components and their relations, finding sociocultural points and connecting them to personal experiences and trying to find answers to questions. Din (2020) and Lai et al. (2019) emphasize that reading alone does not arouse curiosity in people, especially in texts related to academic activities where the results and process of work are precisely described and people are not encouraged to think deeper. They discussed that such a process leads to the lack of awareness and control over the reading process or metacognitive processes in students because they do not learn how to use the information in the text effectively and only focus on the results of the text. Meanwhile, the role of information literacy skills is also well illustrated. This set of basic skills and abilities is essential to know what information is needed, where it can be found, and how it can be evaluated, used, and concluded (Heidari, 2020; Moghadam et al., 2021). As it was mentioned by Rubini et al. (2018), once students gain sufficient skills in information literacy, they can apply them to critical thinking practices, information interpretation and conscious judgment. In such cases, their ability to work independently improves. All in all, the importance of cultivating active citizens, who are able to understand issues, apply critical thinking skills to what they encounter (whether in the form of a text, audio, photo, or any kind of content), formulate and solve problems, and become independent-lifelong learners, is recognized in many societies today (Botturi, 2019; El Hassani, 2015; Hobbs et al., 2013; UNESCO, 2011).

Idea generation

Putting together the findings of previous studies, it can be clearly seen that in all three fields of knowledge related to SDL, DIL and PKM, the evolution process of these concepts initiates from the basic skills of thinking (cognitive skills) and by passing through metacognitive skills, it reaches the presentation of new ideas and attitudes (creative thinking); and this is the concept of complex thinking that has been discussed by pioneers such as Lipman (1997), Pacheco and Herrera (2021), and Tarricone (2011). On the other side of the equilibrium, the concept of critical reading stands out, which also relies on the

three levels of reception, analysis and response according to the critical reading model of the Salisbury University (2009); these three layers can be seen as corresponding to the levels of complex thinking, which initially requires the skills of receiving, understanding, comparing, contrasting and analyzing, and after evolution, it reaches the stages of ideation, providing solutions, creative attitude, explanation and elaboration. The conceptual model of the comparison and adaptation of the variables presented in Figure 1 shows well the adaptability of layers next to each other.

In the meantime, an important issue has recently attracted the attention of a group of Asian researchers, the issue of students' interest in learning. Chan et al. (2018, 2019) proposed the theory of interest-driven creator (IDC) based on which they acknowledged that learners motivated by interest are more successful in creating knowledge, presenting solutions, and generating ideas, and repeating such a process facilitates learning and improves learning performance. Nye et al. (2012) and Wong et al. (2020) acknowledged

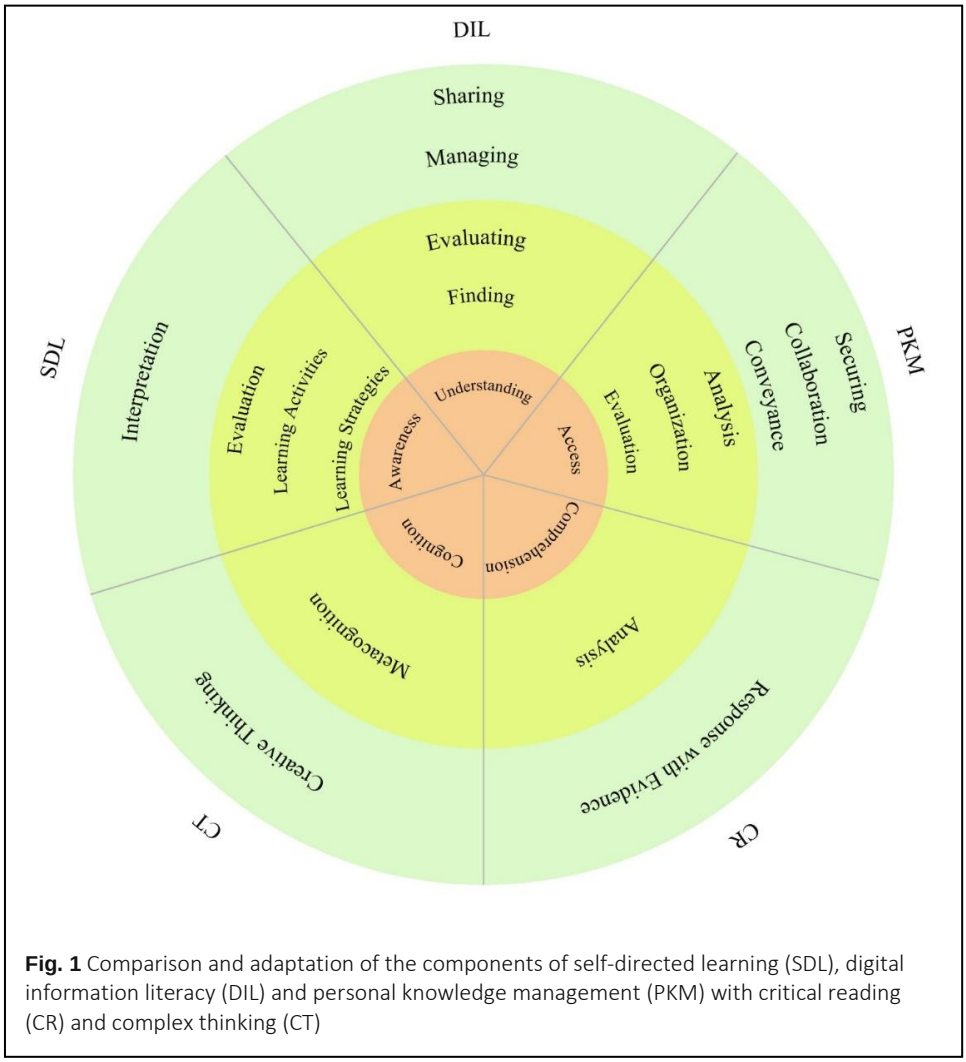

Fig. 1 Comparison and adaptation of the components of self-directed learning (SDL), digital information literacy (DIL) and personal knowledge management (PKM) with critical reading (CR) and complex thinking (CT)

that interest – the primary factor in IDC-based learning – is the most determinant component for attracting students' participation and companionship. They discussed that fostering interest in learning activities leads to the development of individual interests which construct learning interests and cause progression in learning. In this regard, various components of the interest-creation-habit triad are defined as follows:

a. Interest: The first factor of interest is triggering interest in students, which leads to developing interest in learning activities. To maintain and expand learners' interest and participation in language learning, IDC Theory suggests that learning activities should be designed in such a way that they are immersed in interest (Chan et al., 2018; Kong & Wang, 2019). For example, if the prepared and presented materials are liked by students, it will arouse their curiosity to pursue activities and fill the gap of knowledge or information (Kong & Wang, 2019). In the next stage, it is necessary to expand and extend the initial interest that has been formed in them (Kong & Wang, 2019).

b. Creation: The components of the second loop include the imitation, combining and staging (Chan et al., 2018; Kong & Wang, 2019). According to Chan et al. (2019), any learning process begins with imitation of observed and learned materials as an effort to perceive, understand, and respond to issues (i.e., imitating). In the next stages, a person combines, analyzes or interprets ideas and issues by setting goals and choosing the most appropriate method of analyzing information (i.e., combining). Finally, to complete this cycle, language learners must design a method and a platform to explain and present their opinions, ideas or products (i.e., staging). Regarding critical reading, this step refers to the final responses a person provides to the questions raised about texts with analytical-critical content.

c. Habit: The habit loop consists of cueing the environment, routine, and satisfaction (Chen et al., 2020; Kong & Wang, 2019). In general, a habit can be considered as the process of forming a behavior, according to which an action that is performed by a person with a lot of attention at the beginning, is done unconsciously and automatically without direct attention due to repetition and practice (Kong & Wang, 2019). Various studies have explained the relationship between habits and learning - especially language learning. Among them, one can refer to the study of Lally et al. (2010) and Zólyomi (2021), who have focused on investigating how to foster habit formation and explicit-implicit learning, respectively. They emphasized that repeating a behavior leads to the formation of a habit that occurs automatically and with little thought. Chen et al. (2020) emphasized in their IDC Theory that creating a positive learning habit strengthens a lifelong and interest-oriented learning process. They also discussed that in order to develop a habit, one should focus on forming simple and appropriate habits, and the requirement for this action is to

create a context and environment for practicing language. For example, providing conditions for the formation and repetition of a short reading habit or practicing reading strategies. The next steps include repeating these behaviors until they become internalized (i.e., routine). As a result of the formation of this habit and its internalization, individuals can observe their improvement in performing reading tasks and development in responding to reading activities.

Moreover, according to Chan et al. (2019), the IDC Theory promotes the development of competencies required for living in digital natives through emphasizing the three basic concepts of interest, creation and habit. This model emphasizes that in designing learning activities and in order to implement these three concepts, the following strategies can be used: Aligning learning with individuals' interests through the design and presentation of engaging content; creating and provoking interest through designing highly targeted and directed learning activities; and then, repetition, practice and creating daily habits in order to maintain the effect of interest-oriented creation. Advances in networking and communication technologies have also led to changes in instructional methods which can meet the diverse needs of educators and learners (Fahnoe & Mishra, 2013). Several researchers have considered the utilization of hybrid-digital instruction to be effective in developing CT (Atmatzidou et al., 2018) and SDL (Gharib et al., 2016; Karatas & Arpaci, 2021). Daniels and Moore (2000) have pointed out, there are also pitfalls with using online instruction, including limitations on learners' engagement. They emphasized that such an educational context requires spontaneous, self-motivated, and active learners. Dhawan (2020) emphasized that technical difficulties, learners' capabilities, time management, distractions, and reduction of the personal attention to shared feelings between learners and educators may result in the lack of a sense of belonging to the community which influences the learning process. In contrast, hybrid instructions have recently become widely used by teachers, educators and academic staff since the main purpose of such training is to prevail over the shortcomings of online instruction and at the same time, to use different instructional arrangements and strategies in order to improve students' satisfaction and achievement (Geng et al., 2019; Tullis & Benjamin, 2011). In general, hybrid learning implies any combination of teaching-learning delivery methods, mainly including face-to-face and personal guidance instruction with synchronous and/or asynchronous computer technologies (Sriarunrasmee et al., 2015). Studies of technology in education have supported its effectiveness in adaptations and adjustment of education to individual needs (Dillenbourg et al., 2019; Kong & Wang, 2019). Although many efforts in the computer-supported learning community have focused on providing collaborative learning support (Magnisalis et al., 2011), according to Aleven et al., (2017), its most important output is the development of individual learning. In this regard, Dillenbourg et al. (2019) also stated that technologies directly contribute to the implementation and empowerment of IDC, and

those digital environments, in addition to developing the creativity of language learners in creating different solutions for problems (as a part of 3D critical thinking proposed by Mohammadi et al., 2022), facilitate presentation of the solutions and their interpretation by learners, as well as their acceptance by others.

In this study, an attempt was made to use the interest development circles in the IDC Theory, to investigate how interest affects the development of DIL, PKM, and SDL in critical readers. Another main reason for using the IDC Theory in this study was that the level of interest in reading has an effect on the development of reading-related skills and as a result academic-personal success in language learners (Nootens et al., 2019); especially in the situation where many students believe that academic reading is an imposed activity determined by teachers (Conradi et al., 2013; McKenna et al., 2012). It can be inferred that students' interest in reading has decreased under the influence of these factors and many others, and in the most optimistic case, they prefer to study superficial materials instead of studying materials that require analysis and investigation. Therefore, this study aimed at investigating digital information literacy, self-directed learning and personal knowledge management in critical readers through the implementation of IDC Theory and comparing its effectiveness in such readers.

Research questions

This study was conducted to address the challenges of self-directed learning, personal knowledge management, and digital information literacy in performing critical reading tasks and examined whether there is a significant correlation between these factors. In addition, in an attempt to examine the triad of interest-attitude-habit, this study tried to apply the IDC Theory in an innovative-noble manner, based on which the following research questions were investigated:

1. To what extent does the IDC method – compared to non-IDC approach – lead to the development of PKM, SDL and DIL in critical readers?
2. What is the correlation between DIL, PKM, SDL, and CR ability of critical readers?
3. What are the advantages and disadvantages of implementing IDC according to critical readers?

Methodology

Participants

For the purpose of the study, 225 undergraduate students of English language were selected based on their average SAT score (above 22), classified into two intact classes of IDC

Table 1 Sample description

Group	Age	Number	Gender	Number
Non-IDC (G1)	19-24	47	Female	25
			Male	22
	25-30	37	Female	23
			Male	14
IDC (G2)	19-24	50	Female	26
			Male	24
	25-30	30	Female	19
			Male	11
Total		164		164

blended learning type (N = 80) and ordinary blended learning group (N = 84), and were instructed by the same instructor. Their descriptions in this study are shown in Table 1.

Instrumentation

This study has tried to fill in one of the existing gaps in the use of technology in education by relying on the results of previous research.

- *Critical reading:* The researcher used SAT Critical Reading test (Weiner Green & Weiner, 2012) to assess students' critical reading in the phases of participant selection and post-test. The test is composed of 67 questions to be answered in 70 minutes. Cronbach's alpha calculation represented the value of .708.
- *Digital literacy:* The University of Dundee (Jackson & Geenhill, 2016) proposed a standard survey to assess Digital Literacies. This questionnaire consists of 35 closed items to measure 5 literacies namely understanding and engaging in digital practices (9 items), finding information (8 items), information evaluation (5 items), managing and communicating information (7 items), and collaborating and sharing content (6 items) in 35 minutes. Cronbach's alpha calculation reported a value of .85.
- *PKM:* The PKM self-assessment questionnaire was developed by Dorsey (2000) to evaluate seven components of acquiring information and thoughts, appraising, organizing, analyzing, combining and transferring, and sharing them through 35 items in the form of 5-Likert point items. Cronbach's alpha calculation represented a value of .82.
- *SDL:* The Self-Rating Scale of Self-Directed Learning (SRSSDL) questionnaire was developed and validated by Williamson (2007). This questionnaire is a self-assessment tool in self-directed learning that consists of 60 questions measuring five subscales of awareness (12 questions), learning strategies (12 questions), learning activities (12 questions), evaluation (12 questions), and interpersonal skills. (12 questions) in the form of a 5-point Likert scale. The Cronbach's alpha coefficient was 0.81.

- *Interview protocol:* In order to collect the opinions of the participants regarding the implemented instructions and its advantages and disadvantages, an open-ended interview protocol with six questions was designed by the researcher to be conducted in 15 minutes.

Procedure

First, one version of the SAT was used to ensure the homogeneity of the groups. Then the data collection was completed through the collection of documents and questionnaires (pre-tests). In the first week, the texts and reading materials were provided to the learners of both experimental groups through Moodle 4.0 and were made available through the learning management system (LMS). In the first experimental group, all stages of reading, discussing and answering critical reading questions were done in the form of regular-hybrid trainings, while in the IDC group, trainings were carried out in the form of a three-stage process of interest, creation, and habit and in a hybrid format. The trainings of the second week were held with the aim of introducing the concepts and components of DIL and PKM, and the practice of reading the texts continued. In the third and fourth weeks, learners got acquainted with the directions and functions of the GOAL system (i.e., triggering, immersing, and extending), and then they set a one-week study plan in the GOAL system (i.e., imitating, combining, and staging). SDL training in the GOAL system was carried out through the CARE model (Comprehension, Analysis, Response and Evidence). The goal-oriented active learning (GOAL) system designed in this study, in addition to strengthening students' use of fine-grained data in reading activities, provided computer-based scaffolding and practicing tools which lead to the promotion of SDL in students (Li et al., 2021). After the trainings, they adjusted their study schedule for a month, according to their new knowledge (i.e., cueing environment, routine and harmony). Then, both groups were asked to participate in the post-tests (questionnaire and interview). Finally, to analyze the data, collected conversations were immediately transcribed and the process of open coding, axial coding and selective coding was done to classify the responses.

This design was carried out to provide the components of the IDC Theory as follows: In relation to the first component of this theory, interest, and in order to challenge the readers' thoughts and arouse their curiosity and interest in the subject, with the help and guidance of the teachers, the researcher selected texts from the current and favorite topics of the students and provided them to the teachers. The reading activity in the elementary sessions included puzzle activities; based on which, the students read a short text, observed the question, discussed the possible solutions, determined the answer, and if the answer was correct, they received new pieces of information. And this cycle continued until gaining all

Table 2 Study design

Phase	Objective	Function	
Pre-test	- Sample selection - Initial evaluation	SAT test PKM test SDL test DIL test	
		IDC hybrid Group	Non-IDC hybrid Group
Treatment	- Awareness raising	- Introduction to platforms - Introduction to PKM and DIL - Introduction to CR	- Introduction to platforms - Introduction to PKM and DIL - Introduction to CR
	- Training	- Apply CARE model in GOAL system: 1. Comprehension: Learners come across interesting topics that they want to read. So, they take the initiative to gather available and scattered information from self-directed activities, collect diverse data, and engage in reading. (Interest) 2. Analysis: By using the skills and strategies introduced in the training (e.g., imitating), the learners conduct analysis, reasoning, argumentation, etc. and discuss the topic with each other. (Creation) 3. Response: At this stage, the readers choose the direction (determine the answer) by analyzing and measuring the gathered data and relying on individual orientations. This results in formation of reading patterns (i.e., adjusted reading) and defining personal reading. This stage generally includes multiple cycles of planning, organizing, adjusting and monitoring the implementation and continuous reflection of the personal reading patterns. (Habit) 4. Evidence: following the constructed patterns, the readers express their opinions and findings and explain the results of their conclusions and analyses. By practicing such reading processes during the fifteen-week training period, learners will observe the results of the plan, program details, the entire learning process, and their achievements, thus realizing the effects of practicing in a specific time frame. (Habit)	- Practice CR: After getting to know the concepts related to critical reading, the learners started doing this type of activity. Assignments were presented to students (easy level) to practice critical reading. - Practice CR: After getting to know the concepts related to critical reading, the learners started doing this type of activity. Assignments were presented to students (intermediate level) to practice critical reading. - Practice CR: After getting to know the concepts related to critical reading, the learners started doing this type of activity. Assignments were presented to students (difficult level) to practice critical reading.
Post-test	- Final evaluation	PKM test SDL test DIL test Interview	PKM test SDL test DIL test

the required information and reaching the final answer. Regarding the creation process, the students with the knowledge they had acquired from SDL, critical reading and knowledge management guidelines, through imitating the introduced processes and strategies, combining the acquired skills and coming up with original ideas (staging) in the introduced platforms to complete reading activities. Focusing on habit, it is worth mentioning that continuity and persistence in language learning processes are important to facilitate understanding and practice learning. That's why it is important to develop the habit of reading with the right tools. Therefore, in order to develop the habit of reading – and specifically critical reading – the students were asked to use the strategies and skills introduced during the course in reading all the short and long texts that they face daily in different forms (digitally and traditionally). It is worth mentioning that using the IDC processes in the form of a hybrid learning environment allowed students to practice and repeat the processes for a longer period of time and in different forms.

Data analysis

To answer the first research questions, a MANOVA test was conducted to assess the effects of instructions on students' PKM, DIL and SDL. Investigating the second one, a Pearson's correlation analysis was run to examine the correlations between the discussed variables. In order to determine the advantages and disadvantages of implementing this method, the opinions of the participants were classified using MaxQDA through the stages of open coding, axial coding and selective coding, and then the report was presented. Applying a set of hypotheses related to a unified concept, systematic classification of them and providing an inductive theory of a substantive topic, is rooted in the process of developing a grounded theory (Chun et al., 2019; Glaser & Holton, 2004).

Results

In a bid to explore the extent to which IDC instruction leads to PKM, DIL and SDL development in comparison with the non-IDC method of instruction, both descriptive and inferential statistics were estimated. Table 3 showed the descriptive statistics.

Table 3 Descriptive statistics

	Group	Mean	Std. Deviation	N
post.DIL	G2	106.394	6.400	80
	G1	104.643	5.870	84
	Total	105.305	6.153	164
post.SDL	G2	163.150	7.675	80
	G1	161.002	7.079	84
	Total	162.055	7.430	164
post.PKM	G2	118.812	6.477	80
	G1	111.989	7.360	84
	Total	115.317	7.721	164

This table clearly represented the mean and standard deviation of the dependent variables divided by the independent variable (instruction), as well as the "Total" row. In this step, in order to investigate the extent of the difference in the effectiveness of the instructions, first, Leven's test was used to investigate the equality of variances for the variable (Table 4).

The Leven's test's results, as a necessary prerequisite for the MANOVA test, represented that the variances of the groups are equal. Table 5 addressed the multivariate tests results.

One can infer from the multivariate tests table that the level of Wilks' Lambda is significant at .05 meaning that there is a statistically significant difference between groups ($F(3,160) = 15.57$, $p < .05$, Wilk's $\Lambda = .774$, Partial $\eta 2 = .227$). To investigate how dependent variables, differ for the instructions, the tests of Between-Subjects Effects were conducted.

The results of follow-up tests (Table 6) represented that the instructions had influenced DIL ($F(1,162) = 2.006$, $p < .05$, Partial $\eta^2 = .312$), SDL ($F(1,162) = 3.443$, $p < .05$, Partial $\eta^2 = .321$) and PKM ($F(1,162) = 39.578$, $p < .05$, Partial $\eta^2 = .296$).

In an attempt to address the second research question, a Pearson's correlation test was conducted to investigate the correlation of DIL, PKM, SDL, and CR ability of critical readers.

Table 4 Leven's test of homogeneity of variances [a]

	F	df1	df2	Sig.
post.DIL	.179	1	162	.673
Post.SDL	.259	1	162	.611
post.PKM	.597	1	162	.589

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Instruction

Table 5 Multivariate tests [a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Instruction	Wilks' Lambda	.774	15.572[b]	3.000	160.000	.000	.227
	Roy's Largest Root	.292	15.572[b]	3.000	160.000	.000	.227

a. Design: Intercept + Instruction
b. Exact statistic

Table 6 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Instruction	post.DIL	75.470	1	75.470	2.006	.009	.312
	Post.SDL	187.318	1	187.318	3.443	.035	.321
	post.PKM	1908.337	1	1908.337	39.578	.000	.296
Error	post.DIL	6095.286	162	37.625			
	Post.SDL	8813.188	162	54.402			
	post.PKM	7811.176	162	48.217			

Table 7 Pearson correlations analysis

	post.SDL	post.PKM	post.DIL	post.CR
post.SDL	1			
post.PKM	.918**	1		
post.DIL	.933**	.964**	1	
post.CR	.908**	.925**	.961**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The results of the Table 7 showed that SDL had a statistically significant correlation with PKM ($r = .918$, $p < .01$), a strong positive correlation with DIL ($r = .933$, $p < .01$), and a great positive correlation with CR ($r = .908$, $p < .01$). Moreover, there is a statistically significant correlation between PKM and DIL ($r = .964$, $p < .01$), PKM and CR ($r = .925$, $p < .01$), and DIL and CR ($r = .961$, $p < .01$).

In response to the third question, the opinions of learners were categorized in the form of common and frequent phrases and the results were presented in Figure 2.

The coding scheme of the extracted arguments was drawn hierarchically with four levels in MaxQDA, and the definitions were summarized according to Table 8.

Discussion

This study was conducted with the aim of evaluating DIL, SDL, and PKM in critical readers and investigating the effectiveness of IDC Theory. This study explained the correspondence and relationship between the components of the variables by presenting a conceptual model. In the next stage, by planning and implementing the IDC Theory in the

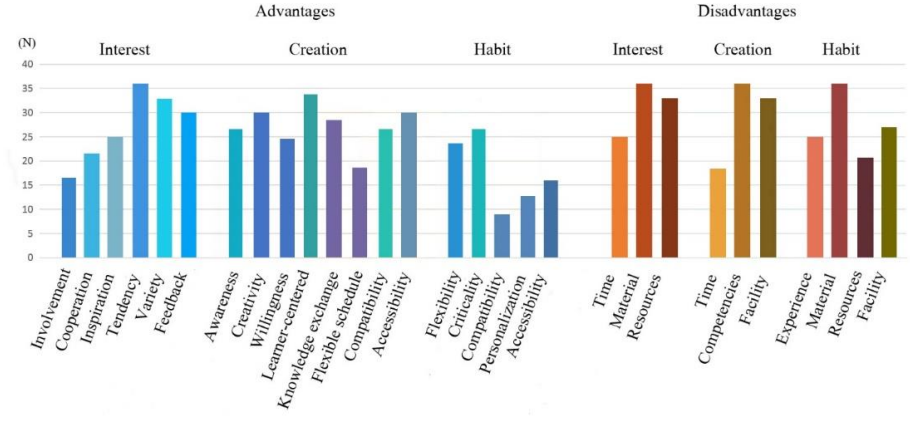

Fig. 2 Advantages and disadvantages of implementing IDC

Table 8 Coding System

Concept	Classification	Theme	Subtheme	Description
IDC	Advantages	Interest	Involvement	The instruction strengthens the participation and involvement of learners in learning activities.
			Cooperation	It makes learners cooperate and collaborate.
			Inspiration	It develops inspiration and motivation in learners.
			Tendency	Improves willingness to read critical texts.
			Variety	It offers diverse topics beyond the normal content of textbooks
			Feedback	It is very motivating to receive personal and confidential feedback.
		Creation	Awareness	It increases awareness of learning.
			Creativity	Enables the search for creative answers.
			Willingness	The desire to learn phrases/idioms is more in this method.
			Learner-centered	It is learner-centered
			Knowledge exchange	It facilitates the exchange and transfer of knowledge between the learners as well as the teacher.
			Flexibility	Offers scheduling flexibility.
			Compatibility	It is compatible with various educational technologies.
			Accessibility	It offers different types of access.
		Habit	Flexibility	Facilitates practice outside the classroom.
			Criticality	It causes the use of cognitive-metacognitive and affective skills in reviewing non-academic contents (i.e., critical action).
			Compatibility	It makes use of all kinds of competencies and skills learned in other courses.
			Personalization	Training is personalized.
			Accessibility	Provides wide and varied access.
	Disadvantages	Interest	Time	Time consuming
			Material	Lack of educational materials to present in the classroom is evident.
			Resources	Lack of learning and practice resources in line with students' interests.
		Creation	Time	Time consuming.
			Competencies	New skills are required.
			Facility	Lack of facilities (equipment, learning tools, technologies, etc.)
		Habit	Experience	Students do not have the necessary experience and this makes the learning process time consuming.
			Material	Lack of teaching materials to present in the classroom is evident.
			Resources	Lack of learning and practice resources for students according to each person's abilities.
			Facility	Lack of facilities (equipment, learning tools, technologies, etc.).

hybrid classes, it presented a quantitative-qualitative analysis of the variables that improves the understanding of the effectiveness of interest-attitude-habit loops. The findings of this research revealed that the application of technologies – along with IDC – increments PKM, SDL and DIL in language learners. Such a finding is consistent with what was previously reported by Dillenbourg et al. (2019), Fahno and Mishra (2013) and Silamut and Petsangsry (2020). Fahno and Mishra (2013) and Silamut and Petsangsry (2020) acknowledged that a technology-rich learning setting could prove learners with many opportunities for self-learning. Focusing on the improvement in students' CR, Brix (2017) and Raudeliūnienė and Račinskaja (2014) have represented that the knowledge used by an individual creates more value in their problem-solving and decision-making activities. Similarly, Akyuz and Samsa (2009), Picciano (2009), and Sriarunrasmee et al. (2015) represented that hybrid learning improves learners' SDL. They emphasized that such learning required suitable learning exercises and context. It is not just about how instructors mix eye-to-eye interactions with the utilization of technology, rather, the substance and motivation behind the information literacy training itself should support students to be long-lasting persons. Individuals are also expected to foster their SDL abilities to gain the objective of the class, i.e., being deep-rooted dynamic learners. This is the point that Cheng et al. (2019) and Kong and Wang (2019) acknowledged regarding the IDC cycle. They discussed that by creating interest and fostering the processes of creation and habit formation, a person gets a permanent and lifelong interest in learning, which causes the growth and development of learning independence.

Focusing on the second research question, the findings of the research represented that the relationships between the components of this study (Figure 1) were drawn properly. DIL was defined by American Library Association (2013) as a set of capacities that are required in determining data, identifying and searching for data, evaluating and finally using them (i.e., critical reading). Moreover, as it was mentioned by Sriarunrasmee et al. (2015), e-learning and interpersonal skills are devices to foster participants to find out more and to make the learning context more advantageous for them and teachers to accomplish their objectives. According to Sriarunrasme et al. (2015), such learning basically serves as a computerized classroom that gathers all materials and understudies' works together. Moreover, students can observe their activities, tasks, and practices by comparing them with friends' and teachers' audits. In addition, e-learning devices contain interfaces which provide learners with many features such as learning logs, declarations, talk, discussions, task updates, etc. They added that most teachers and learners observe these highlights valuable which support them to foster self-directed learning. In this regard, as Rubini et al. (2018) stated, increasing information literacy skills in students improves their critical skills, so that they can interpret information and make informed judgments. Moreover, hybrid instruction was also more effective than online instruction, which was a confirmation of

previous findings in the studies of Tullis and Benjamin (2011); they demonstrated that the context of hybrid learning, with more emphasis on the self-directed aspects of learning and opportunities to interact with other students and educators through digital discussion and self-controlled access to multimedia educational content, leads to more effective learning.

Concerning SDL and DIL, it was found that hybrid training has led to the growth of these two factors, which was also mentioned in the research of Uz and Uzun (2018) while in this study, application of the IDC Theory has led to the further development of these factors. In describing such conditions, it can be said that as it was pointed out by Geng et al. (2019), self-directed learners actively and continuously participate in learning processes and have the ability to choose appropriate learning strategies according to the context. This issue is important in knowing how to apply knowledge (Heidari, 2020; Moghadam et al., 2021) as well as how to use information in reading (Din, 2020; Lai et al., 2019) and it can be concluded that such features have been developed through the loops of creation and habit. In confirming the correlation between different factors, one can refer to the study of Silamut and Petsangsri (2020) based on which they propose the more students get involved in SDL and KM activities using digital technologies, the better DIL abilities will be acquired. SDL had a statistically significant correlation with PKM which was previously introduced by Fujita (2020) and has a strong positive correlation with DIL.

Concerning the third research question, the findings indicated that the language learners of the IDC group have reached a proper understanding of all three components of interest-creation-habit and were able to clearly explain their needs and desires in using this method. The findings of this section were initially identified in the three general characteristics of participation, perception-interest, and facility-opportunity, and then each of these characteristics was searched in the three components of the IDC cycle.

Conclusion

This study explained the relationship between DIL, SDL and PKM factors and by presenting a conceptual model of the relationship between these components, it investigated their development in critical readers in the conditions of the implementing IDC loops.

The findings of this study demonstrated that trainings improved PKM in both groups of critical readers and students trained under the IDC loops outperformed other group in these two areas. Participants in the IDC group also surpassed participants of the non-IDC group in terms of DIL and SDL; there is a strong correlation between the three factors of DIL, SDL, and PKM, in such a way that with the improvement of one, the others also grow. The findings suggest that learning and practicing the skills of DIL, SDL, and PKM are important factors in a technology-based reading environment and that it affects the development of critical reading in individuals. This study also examined the effectiveness

of IDC implementation in nurturing DIL, SDL, and PKM; hence, it expands the literature on IDC Theory and its impacts on language learning and critical reading that have not been sufficiently studied. These findings also revealed that according to the participants of the IDC group, interest-creation-habit loops have strengthened their participation, inspiration, awareness, knowledge exchange and cooperation, while it has also caused problems such as: learners need resources to practice more relevant activities outside the classroom; language learners need more resources to practice more related activities outside the classroom; they need more time to practice and repeat what they have learned; and that they need to develop their digital skills.

As shown in the proposed quintet model, the sub-factors related to the triad of SDL, DIL and PKM are related to each other in such a way that it causes the development of cognition, metacognition and creativity in language learners and as a result, the transformation from novice critical readers to proficient critical readers. While this study attempted to first examine the links between DIL, SDL, and PKM in critical readers and measure the efficacy of IDC Theory, some limitations were also observed. First, the relationships between the factors and their effects were specifically investigated in the application of the GOAL system during the study. This relationship may vary in other learning environments or other forms of learning. In addition, the participants in this study have a close scientific background. Therefore, it is suggested that in future studies, wider communities with more dispersion and diversity to be investigated. It is also recommended that different structures and exercises to be designed for each of the interest, creation and habit loops, in order to compare the effectiveness of each and, if possible, provide a clear operational framework for instructors.

The results of this study have some implications for researchers studying the DIL, SDL, and PKM. First, a hybrid reading context has potential benefits if it integrates DIL and SDL elements. As it turned out, the three variables (DIL, SDL, and PKM) have several elements in common, thus if the DIL and SDL elements are considered in an integrated reading activity (as in this study), not only will it provide students with a wealth of reading resources, but it can also provide plans to support the development of DIL and SDL elements as well. This way, one can focus on both the critical reading skills of individuals and the process of goal-setting, planning, controlling, and learning (i.e., SDL development); both in the form of knowledge development and knowledge management of the digital context (DIL). Second, from the correlation of DIL, PKM, and SDL factors, it can be inferred that these factors are intertwined, especially in the context of technology-based learning. In such a context, people in search of information are faced with a variety of content that must be critically examined and evaluated in order to find the information they need and be able to use it. Therefore, paying attention to these concepts simultaneously

makes learners know the necessary skills, practice to use them and internalize the ability to use them in their daily activities.

Finally, as a critique to the IDC Theory, Chan et al. (2018) acknowledged, it focuses on the design of education, while action and implementation require steps beyond design. The needs and abilities of each learning group, each lesson, each in-class/outside class activity requires adaptation of the new conditions with the previous plan and the application of various changes, and this is the same issue that is not considered in most theories and the responsibility of their implementation is given to teachers. This research also demonstrated that as Aleven et al. (2017) and Magnisalis et al. (2011) acknowledged, computer-supported learning leads to the development of personal learning, especially DIL, SDL, and PKM in Critical Readers.

Abbreviations

CARE: Comprehension, Analysis, Response and Evidence; CR: Critical Reading; CT: Complex Thinking; DIL: Digital Information Literacy; DL: Digital Literacy; DML: Digital Media Literacy; GOAL: Goal-Oriented Active Learning; IDC Theory: Interest-Driven Creator Theory; KM: Knowledge Management; LMS: Learning Management System; PKM: Personal Knowledge Management; SDL: Self-Directed Learning; SRSSDL: Self-Rating Scale of Self-Directed Learning.

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Author's contributions

The author is responsible for the whole manuscript. The author read and approved the final manuscript.

Author's information

M. M. is focused on research in educational topics. Her research interests include teaching-learning topics, media and technology in education, language acquisition, multilingualism, simulating educational issues, classroom leadership, and curriculum development.

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