

## On-line learning on information security based on critical thinking andragogy

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**ABSTRACT:** There is a demand in higher educational institutions for an on-line learning model that positively stimulates learners' critical thinking. Higher education learners are considered adults. Thus, standard pedagogical approaches do not always work. Adults need an andragogical approach that takes into consideration that teaching is relevant to them. Andragogy refers to adult teaching theories. In this article, the authors propose a new model that intends to provide an effective on-line teaching environment that applies critical thinking andragogy in higher education. The model was applied to 140 learners of the Basics of Information Security course at Zayed University in Abu Dhabi, the United Arab Emirates. This course was specifically chosen because the skills taught in this course are used in real life, while dealing with e-mails, Web sites, social networks and other on-line platforms. Thus, an andragogical approach seemed appropriate. Learners' response to the applied model was measured through a quantitative research method. There was noticeable student satisfaction regarding the applied framework. The authors describe the model in detail and how it was utilised.

### INTRODUCTION

In higher education, it is crucial to change the teaching methodologies and shift from pedagogical to andragogical approaches. Andragogy refers to the adult teaching methodologies. It is a Greek word that means man-lead, whereas pedagogy means child-lead [1]. Knowles was the first to introduce this concept [1]. Andragogy and pedagogy share the same pillars of a lesson; however, how the learner is acting in the lesson is different. When applying an andragogical approach, there should be a consideration of the learners' prior life experience, readiness and motivation to learn.

With the growing demand for information and communication technologies (ICT) in higher education and their continuous progress, lecture-based classes are now outdated strategies in higher education. There is a significant shift in instruction which it is no more teacher-centred, but student-centred to develop an active learner [2]. Maintaining an active learning environment not only focuses on learners' engagement in the process, but also on enhancing their learning skills, specifically critical thinking. Through a knowledge gap, the concept of critical thinking in an on-line context is often not researched well regardless of its significant importance in an on-line context. New frameworks are demanded to improve learning competencies and performance in an on-line context.

Adopting a new innovative shift that requires ICT integration in an on-line learning environment, learners' behavioural intentions and challenges while using ICT tools should be considered. In the study by Masilo et al, learners show a positive attitude towards using those tools in the future [3]. However, some challenges, such as technical problems by the learners, are faced. In order to handle such challenges, an e-learning framework is needed. On the other hand, another study suggested a conceptual framework following the grounded social constructivist approach joined with a deductive thematic thorough analysis and an evaluative framework to explore on-line learning-based strategies and how they boost learners' engagement in learning [4]. Wingo et al considered five leading indicators in the on-line learning frameworks: emotional engagement, collaborative engagement, behavioural engagement, cognitive engagement and social engagement [5]. In their study, the technology acceptance model (TAM2) framework was proposed [5]. The results of another study showed that the instructors believed effective communication, technical proficiency and legitimate achievement of learning outcomes were the main contributors to learners' success [6].

In their study, Kaddoura and Al Hussein described an approach to reinforce active learning in higher education for IT learners [7]. The results showed a high interest on the student's level, while using on-line learning tools. The study by Picciano approve the need to adopt new teaching styles in higher education to meet the student's expectations for more engagement and interactivity [8].

Several research publications examined various aspects of on-line course facilitation. In their study, Hosler and Arend found that discourse facilitation is vital to enhance critical thinking or cognitive presence [9]. The course organisation

and timely precise feedback boost learners' participation. Wardani et al investigated the effectiveness of on-line learning information systems to boost undergraduates' critical thinking skills in learning macroeconomics applying quantitative methods [10]. They supported their research by a questionnaire that measured the effectiveness of on-line learning on enhancing critical thinking skills. The research findings prove the correlation between critical thinking skills and on-line learning media [10]. Avsec and Jerman explained how critical thinking and creativity could be developed in an on-line learning environment [11]. It is widely recommended that today's learning environment must be constructed upon the student-centred approach, and based more on andragogy than pedagogy. This facilitates learning and boosts critical thinking.

Besides, in a qualitative multi-case study analysis that aimed at exploring the pedagogical tools used in 24 MOOCs, the extent to which these courses allow learners to benefit from high-quality, collaborative learning experiences in an on-line environment was investigated. Results revealed that the dimensions of the on-line pedagogical practices being used in MOOCs support an objectivist-individual approach that integrates a constructivist and group-oriented approach in an on-line learning environment. However, in regard to engineering learners, the specific indications of this approach cannot be considered [12].

To examine the effectiveness of blended learning models in enhancing critical thinking and communication with learners of electronic engineering a quasi-experimental study was conducted. This study's findings showed that the experimental group's critical thinking skills post blended learning model instruction revealed a positive difference compared to the control group that followed a traditional learning model [13]. In the same sense through a full review about approaches and models used in cultivating critical thinking, the role of e-learning in promoting it was presented. The study concluded that higher education's current role is to develop independent and critical citizenship that prepares learners for an efficient role in the workplace. Embedding ICT fosters this global citizenship approach, which is strengthened by on-line learning with its blended, distributed, problem-based and Web-based learning [14].

## CONTRIBUTION

The overall goal of this study was to create a model from an andragogical perspective to be implemented in higher education. The target course was Information Security Basics at Zayed University in Abu Dhabi, the United Arab Emirates. A major objective of this study was to enhance the critical thinking skills of the learners and their overall academic performance in on-line classes. Hence, the significance of this study lies in combining a pedagogical approach with an andragogical one to form a learning model that could be applied in an on-line virtual classroom to balance, integrate and develop the student's critical thinking.

## THE ON-LINE LEARNING MODEL BASED ON CRITICAL THINKING ANDRAGOGY

Knowles introduced the concept of andragogy, i.e. adult learning, and considered five assumptions: self-concept, adult learners' experience, readiness to learn, orientation to learning and internal motivation [1].

The first assumption is self-concept, where the learner is assumed to have an independent rather than a dependent personality. What is crucial about self-concept is that a pedagogical approach assumes that the learner depends on the teacher. The teacher is the director of what is to be learned and how it is delivered. However, in andragogy, the learner is independent and self-directed. The teacher's role is to nurture learning and be responsible for the classroom settings. The second assumption is about the adult learner's experience, where the learner's previous experience affects the learning process. In a pedagogical approach, a learner's experience has little effect on the teaching/learning process, whereas, in an andragogical approach, learners' various experiences affect how they perceive the topics to be learned. Thus, more advanced teaching methods should be incorporated in the latter approach, such as discussions, problem solving, projects, etc. Readiness to learn is the third assumption, where learners are oriented towards tasks that affect their social role. In the pedagogical approach, learners know what they need to pass a course rather than learning what they will apply in real life. However, in andragogy, learners should link each topic to real life situations. Orientation to learning is the fourth assumption, where learners are expected to shift from postponed knowledge in pedagogy, to immediate application in andragogy. In other words, from subject-centred to problem-centred. Finally, the fifth assumption is about internal motivation. Adult learners are motivated to learn in order to acquire new skills and to increase their self-esteem. Hence, andragogy is different than pedagogy, where the teacher motivates the learner.

In this article, the authors propose an on-line learning model based on critical thinking andragogy. As shown in Figure 1, the model considers different aspects of the teaching/learning process, where they intersect into critical thinking andragogy. This model is proposed and applied for higher education learners. When developing a model for on-line teaching, interlinks among all the below-listed pillars need to be identified. The following model will allow instructors and learners to better use on-line learning and enhance critical thinking skills in an on-line environment.

### Central Pillar: Critical Thinking Andragogy

While developing critical thinking andragogy, Knowles principles were applied [1]. At the beginning of each topic in the course, the instructor explained why this topic was included in the syllabus and how it could impact the learner's life. Because the course is on information security basics, it is directly related to every learner's daily life. This course is about increasing the user's awareness of cybersecurity. Thus, before teaching any topic, the applications of this

particular topic in daily life were explained in detail. The course content was divided into six sections. Each section is about a different aspect of the user's technological life: cyberattacks, personal security, computer security, Web and on-line security, mobile device security and network security. In each section, the learner knows ahead of why the topic is included in the course. At the end of the topic, the learner knows how to be secure from attacks in each section. Adults are self-directed learners, thus they should discover knowledge by themselves. In this model, the instructor's role is just to provide guidance rather than teach. The following pillars show how Knowles principles were applied. Table 1 shows the links between the model pillars and the Knowles assumptions. The links are explained in the following sections.

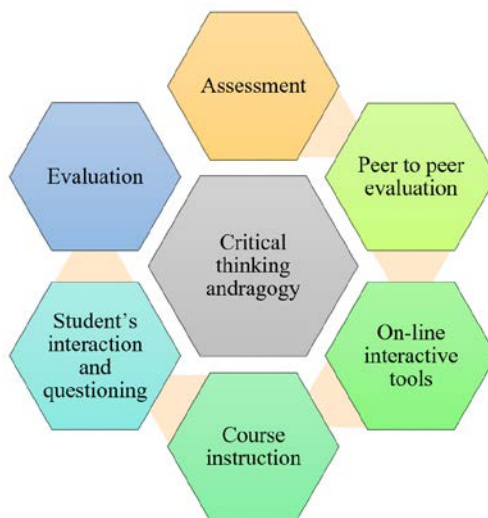


Figure 1: On-line learning model based on critical thinking andragogy.

Table 1: Links between the model and the Knowles assumptions.

Model pillar	Knowles assumption
1	Readiness to know, orientation to learning
2	Adult learners' experience
3	Motivation
4	Motivation
5	Adult learners' experience, orientation to learning
6	Self-concept

#### Pillar One: Course Instruction

In an andragogical approach, instructions should be task-oriented instead of rote learning and memorisation. Thus, the task given to learners includes real-life cases adapted from recent cyberattacks. One example is to consider a recent cyberattack in a particular company and ask the learner to analyse and extract the vulnerability and the tool used to make this attack successful. Thus, the readiness and orientation to learning concepts are applied here.

Within an on-line context, creating a collaborative and engaged class during course delivery develops an atmosphere of active participation [7]. It starts with setting learning goals, instruction and learning activities, feedback and assessment, and most importantly, an environment that pushes the student to be an active learner [7].

#### Pillar Two: Learner's Reflection and Questioning

In adult learning, learners' background knowledge should be considered because it affects their performance. Learning materials should accommodate different levels of learning and background knowledge. In this study, the materials varied between book, PowerPoint presentations, on-line readings and practical laboratories. Each topic was included in all the learning materials from a different perspective. In laboratories, it was practical, whereas on-line reading was based on real-life incidents. The book and PowerPoint presentations included theories. Hence, the role of experience was utilised in this pillar.

The implementation of the reflection and questioning approach showed effective engagement within an on-line context [15]. This approach within an on-line teaching environment consistency showed that being critical in the learning processes improved learners' overall performance, including critical thinking [16].

#### Pillar Three: Evaluation

It is important for learners to develop an effective learning strategy when learning on-line. This creates a high level of motivation that boosts their self-efficacy in an on-line context. Thus, motivation, yet another of Knowles' assumptions

is applied in this pillar. Once learners demonstrate a self-regulated learning behaviour in on-line learning settings their overall learning style is enhanced [17]. The evaluation strategy should not only be based on examinations, but include projects and practical laboratories. The project should be about a real-life cybercrime that permits the learner to learn about a recent attack and its impact on the society. In addition, the practical laboratory enable the learner to apply skills needed in the workplace. The laboratory activities, in this study, were suitable to be applied on-line and at the same time added value to the adult learner.

#### Pillar Four: Assessments

Assessments within an on-line learning environment are vital to develop learning outcomes and skills. It has been proven that using forum submissions and attending on-line lectures positively impacted learners' achievements [18]. In an on-line environment, analytical tools can determine and facilitate instruction and learning. Learning analytics can be useful in following up learning development and demonstrating improvement on the level of learners' self-regulated learning and their increased time management skills [19]. This method permits the instructor to evaluate the learning process based on software functionality, and at the same time to create other approaches to improve learning within a virtual learning environment [20][21]. The motivation assumption is applied here since assessment gives the learner a view about the performance and allows measuring goal achievement.

#### Pillar Five: Peer to Peer Evaluation

Peer-to-peer evaluation allows active engagement and facilitates the learning process. In their study, Li et al proved that learners believe that peer assessment improves their learning through guided feedback [22]. However, having a peer assessment system in an on-line context demands further research to identify the areas in which it impacts the learner's skills. This pillar is not applied in this study due to time constraints and the need to prepare more assessments suitable for peer evaluation. It will be studied in the future for the same course using the same model [23]. Peer-to-peer evaluation utilises the Knowles assumption about the adult learner's experience and orientation to learning. Peers will evaluate each other based on prior knowledge and experiences. Thus, experience sharing will be cultivated while applying this pillar. Learners may change some concepts or acquire new experiences from each other.

#### Pillar Six: On-line Interactive Tools

Utilising on-line interactive tools, such as Nearpod, is essential for successful learning in an on-line learning environment [7]. On-line interactive tools are used to reflect on the educational potential and create a suitable strategic environment that allows a variety of on-line learning and instruction. When learners highly value on-line tools, it results in higher scores and performance [24]. The Knowles assumption on self-concept comes under this pillar. The learner is self-directed, but is not aware of how to apply it in a classroom setting. So, an on-line interactive tool will facilitate this task.

### SAMPLE

The study was conducted at Zayed University in Abu Dhabi, the United Arab Emirates. The target course was Information Security Basics, which is an introductory course to information security. It focuses on raising learners' awareness of cybersecurity and teaching them how to be secure and safe while using technology. This course was specifically chosen because it is directly related to learners' daily life and potential cyberattacks. All the skills attained in this course are used in real life while dealing with e-mails, Web sites, social networks and other on-line platforms. The participants in the study were a cohort of 140 learners divided equally into five sections. The course content and nature are excellent targets for critical thinking. Throughout the course, the learners face many case studies from real life to decide whether a situation is secure or under a cyberattack.

### QUESTIONNAIRE

When developing this model, the researchers followed a questionnaire approach through learners' feedback to measure the model efficacy. The questionnaire was constructed on Google Forms. The link to the questionnaire was sent to the learners via their institutional e-mails. The questionnaire followed a Likert-type scale for question responses. Table 2 includes the questions. Attached to the questionnaire, was a consent form for the learners' ethical approval, where they also had the option to say no.

Table 2: Questionnaire items.

Q1	I am very interested in the content area of this course.
Q2	I am interested in ICT tools in my learning process, such as Nearpod.
Q3	I agree that ICT tools attract my attention and it fosters learning motivation.
Q4	I agree that the use of ICT can increase my critical thinking ability.
Q5	I am interested in the brainstorming techniques used during the session using digital tools.
Q6	I often find myself questioning things I hear or read in these classes to decide if I find them convincing.
Q7	When a theory or interpretation is presented in class, I try to decide if there is good supporting evidence.

Q8	I treat the course material as a starting point and try to develop my own ideas about it.
Q9	If course material is difficult to understand, I change the way I read the material.
Q10	I ask myself questions to make sure I understand the material I have been studying in class.
Q11	I try to change the way I study in order to fit the course requirements and the instructor's teaching style.
Q12	I try to think through a topic and decide what I am supposed to learn from it rather than just reading it.
Q13	When I study, I set goals for myself in order to direct my activities in each study period.

## FINDINGS AND DISCUSSION

The results collected through the learners' responses reveal a positive connectedness to the suggested pillars of the model. As presented in Figure 2, when it comes to the degree of interest in the course content area, as asked in question one, 69% of the respondents answered strongly agree, 16.7% answered agree and 14.3% were neutral.

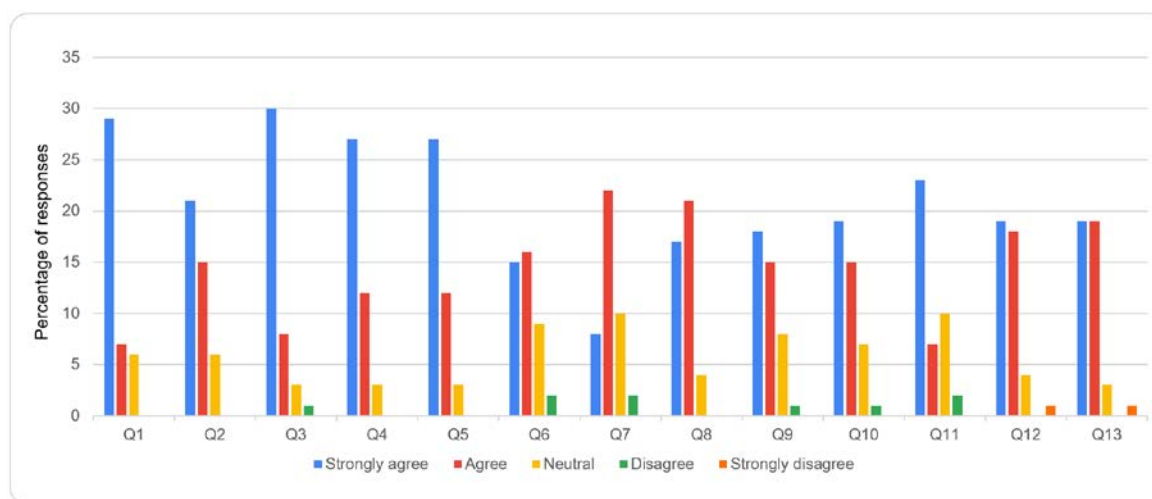


Figure 2: The questionnaire results.

In regard to the degree of interest in ICT tools during the learning process, 50% strongly agreed, 35.7% agreed and 14.3% were neutral. When learners were asked about the power ICT tools have on developing their learning motivation, 71.4% strongly agreed, 19% agreed, 7.1% had neutral responses, and only 2.4% disagreed. The responses show that 90.4% of the learners believe in ICT's ability to create a motivating learning environment. Another question was targeting the assumption that ICT can increase critical thinking ability. The results were significant with only 7.1% neutral responses and around 93% showing positive emphasis, with 64.3% strongly agree and 28.6% agree. Sixty-four point three percent of learners showed significant positive interest in the brainstorming techniques during the session using digital tools, with 28.6% that agreed, which is still a positive indicator, while only 7.1% had neutral responses.

When asked about the level of questioning when they hear or read in these classes to decide if they find the ideas convincing, 35.7% of the learners replied strongly agree, 38.1% agreed and 21.4% had neutral responses, leaving only 4.8% with the disagree response. In regard to the research question targeting the examination of the degree of decision-making learners could reach when a theory, interpretation or conclusion was presented in class or readings, a significant indicator was revealed to support the importance of the proposed model. Specifically, 19% strongly agreed, 52.4% agreed, 23.8% were neutral answers and only 4.8% had the disagree response. In answering the question about the extent to which the learners consider the course material as a starting point to develop their own ideas, 40.5% strongly agreed, 50.8% agreed and 9.5% had neutral responses. The question that aimed at exploring whether the learners change the way they read the material when they face a complex topic to understand, resulted in 42.9% that strongly agreed, 35.7% that agreed, 19% that were neutral, while only 2.4% disagreed. Moreover, when examining if the learners ask questions to make sure they understand the material presented in class, 45.2% strongly agreed, 35.7% agreed and only 16.7% were neutral. Concerning their attempts to change how they study to fit the course requirements and the instructor's teaching style, 54.8% strongly agreed, 16.7% agreed, 23.8% were neutral and just 4.8% disagreed.

In regard to their attempts to examine a topic and decide what knowledge they should extract from it rather than just reading it, 45.2% strongly agreed to this statement, 42.9% agreed, 9.5% had neutral responses and only 2.4% strongly disagreed. In response to the last question about the learners setting or not setting goals for themselves to direct their activities in each study period, 45.2% strongly agreed, 45.2% agreed, leaving 7.1% with neutral responses and merely 2.5% that strongly disagreed.

## CONCLUSIONS

Creating an on-line learning model to advance critical thinking skills in an on-line context is a challenging need. The new teaching methodologies should meet up with the 21st Century learner whose competencies surpass basic skills.

The authors present a new model for an effective on-line teaching environment that applies critical thinking andragogy in higher education. There is a demand to move out of a traditional pedagogy into andragogy to prepare independent learners who can compete in a global market for higher education graduates. The model was applied to higher education learners in a cybersecurity course in Zayed University, Abu Dhabi, the United Arab Emirates. The learners showed positive feedback towards the applied model.

As future work, a peer-to-peer evaluation will be implemented and measured in the same course. Learners' engagement while applying this model will also be studied. There are five areas of engagement: emotional, collaborative, behavioural, social and cognitive [5]. Their incorporation into an andragogical approach will be further investigated.

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