Factors Influencing Students’ Attitudes and Readiness towards Active Online Learning in Physics

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Abstract: Many factors can influence students’ attitudes and their readiness to learn, especially with respect to learning physics online. Traditional online learning, where the teacher is the sole speaker, is inappropriate for learning physics because there must be live demonstrations and activities connecting theories with real world experiences. Online learning for physics must be active and engaging. Students would find the traditional form of online instruction difficult, because there is no physical social interaction between teacher and students. In our teaching work, we have found that factors such as computer skills/ICT skills, learning preferences, prior knowledge and motivation are important for students’ learning. What are the perceptions and attitudes of learners regarding these factors? The aim of this paper is to investigate the attitudes of students’ responses to computer/ICT skills, learning preferences, prior knowledge, and motivation pre-online learning and post-online learning in a case study. The research used a hierarchical regression for data analysis across a sample of young respondents who studied physics at Labuan Matriculation College, i.e., pre-university, in year one of their enrolment. The study involved two phases. A survey was conducted to assess the attitudes of the students prior to the implementation of active online learning. The pre-survey results showed that students considered learning preference and motivation to be important factors that would influence their active online learning. Post-survey responses and views communicated after completion of the learning revealed that all four factors have positive influence in their learning. Principles from neuroscience were used to explain why these four factors were important. The paper also provides guidelines on how teachers can use principles from neuroscience to help students to improve active online learning based on these four factors.

Keywords: online active learning; computer skills; ICT skills; learning preferences; prior knowledge; motivation; neuroscience; educational neuroscience

1. Introduction

‘Active learning’ refers to a broad range of teaching and learning strategies which engage students as active participants in their learning. Normally, in active-learning sets, students will be asked to engage in the learning process. This involves students cooperating during class. It may involve individual work and/or reflection [1]. Active learning is different from ‘traditional’ learning or instruction in which students are passive recipients of knowledge from a teacher. There are plenty of well-documented advantages of active learning i.e., [2–5]. According to these researchers, active learning ideally consists of integrated instructional practices; personalized feedback; pre-reading and preparation; motivation and relevance; immediacy in response from lecturer; collaborative learning; provision of just-in-time feedback, formative assessment; personal response from and engagement with academics: in essence, student-centered learning.

Active learning is an approach to instruction that involves actively engaging students with the course material through discussions, problem solving, case studies, role playing,
and other methods. Students find this approach difficult because they are used to being taught in the traditional method of lecturing. Despite the many advantages to be gained from active learning, it is different when it comes to active online learning. This is even harder for active online learning where there is no physical social interaction between teacher and students. One of the important factors related to this transition is the attitude of learners.

Brown [6] defines an attitude as emotional involvement, such as feelings, self, or relationships in community. Attitude shapes our life and our feelings toward the external world. A disposition to respond favorably or unfavorably to an object, person, institution, or an event is considered by Ajzan [7] to be attitude. According to Baker [8] an attitude is a hypothetical construct used to explain the direction and persistence of human behavior. The cognitive component consists of the beliefs and ideas or opinions about the object of the attitude. The affective component is the feeling and emotions that one has towards an object, “likes” or “dislikes”, “with” or “against”. The behavioral component refers to one’s actions or behavioral intentions towards the object. Learner attitude plays a significant role in online learning, [10]. It is important to find out students’ attitudes on computer skills/ICT skills, learning preferences, prior knowledge, and motivation in their online learning. According to Weinburgh [11], attitude influences behavior and achievement. Positive and negative attitudes have strong impacts on students’ online learning.

According to researchers, e.g., [12,13], the learners’ attitudes and perspectives towards online learning are key factors for their learning outcomes. Lim et al. [14] argued that students’ positive attitudes towards online learning are critical to their readiness and their inclusion in online learning. Understanding this will help universities and the academic staff to develop and apply appropriate models and forms of online learning to meet the students’ needs.

There are many factors affecting online learning. These include engagement [15], inadequate personal interaction [16], and interaction with teachers and peers [17]. Based on our personal teaching experiences of physics, it is our belief that computer skills/ICT skills, prior knowledge, learning preferences, and motivation are important. Students who are used to traditional teaching and learning would feel uneasy with the active online learning. Fauziah [18] reports that students have difficulties when studying online, particularly during the freshman year. The disadvantages include that discussion is difficult to handle, and there is limited ‘space’ of the communication medium, lack of cooperation from group members, very little guidance from the facilitator, and a lack of clarification at the start of the assessment.

The authors have been implementing active online learning for several years for physics students in Malaysia. This paper describes a case study to investigate the attitudes of students on factors such as computer skills/ICT skills, prior knowledge, learning preferences, and motivation towards active online learning. It was our belief that knowing their attitudes would help us to design better active online learning. The four factors also are affected by our understanding of how the brain learns. This has important implications for teachers seeking to help students to learn better. Principles from neuroscience can help us to understand the attitudes of students and design better learning for them.

Our study aims to investigate the attitudes of the students as to the four factors relevant to active online learning for freshman students in a college in Malaysia. The investigation involves finding the attitudes of the students, by means of a survey before the active online learning, toward the four factors and then taking a post-survey of their attitudes after the implementation to see if there were differences. Principles from neuroscience are used to explain their post-implementation attitudes. We also provide guidelines that can be used to help teachers to implement active online learning based on these four factors.

The paper begins with a brief review of active learning, especially matters related to active online learning, followed by the factors affecting online active learning. A brief review is given to neuroscience. Subsequent sections describe the case study and the
methodology for the study. This is followed by findings and discussion. Guidelines based on principles from neuroscience are provided for teachers to use to promote the four factors: computer skills/ICT skills, prior knowledge, learning preferences, and motivation for active online learning. The paper concludes with suggestions for further research.

2. Active Learning

Before discussing active learning, we will clarify the differences between distance education, online learning, distance learning and blended learning. There is often confusion between distance education, distance learning, and blended learning, but there are differences between them. Distance Education (DE) is planned and organized teaching and learning where learners are separated from teachers or facilitators in time and space. Blended learning is where both online and in-person teaching and learning take place. Online learning is sometimes called e-learning, and often gets confused with distance learning; however, there are differences between them [19]. In online learning, students can be together in the classroom with their teacher while working through their digital lessons and assessments. Distance learning is where students work online at home and the teacher assigns work and checks them digitally. There is also interaction and location between the two. Online learning involves interaction between teacher and student on a regular basis. On the other hand, in distance learning, there is no in-person interaction between teacher and student. Communication between teacher and student is done through using digital forms such as email, discussion boards, messaging app, video call and learning management systems (LMS). There are several benefits of online learning including flexibility, the possibility of learning at one’s own pace, there being no need to attend classes etc. [20].

Bonwell and Eison [21] describe active learning strategies as “instructional activities involving students in doing things and thinking about what they are doing”. Active learning as an instructional approach engages students in the material they are learning through problem-solving activities, writing assignments, group discussion, reflection activities, and any other task that promotes critical thinking about the subject. It requires students to do something that develops their skills, as opposed to passive learning where information is merely transmitted to students. Freeman et al. [22] has performed a meta-analysis of 225 studies comparing active learning approaches with traditional lecturing, and showed improved exam scores and decreased failure rates for active learning. It is generally accepted that students retain more knowledge when actively engaged in the learning process, and active learning is often cited as an extremely effective instructional strategy [23,24].

There are many well documented advantages of active learning, i.e., [25–27]. According to these researchers, active learning ideally consists of integrated instructional practices; personalized feedback; pre-reading and preparation; motivation and relevance; immediacy in response from lecturer; collaborative learning; provision of just in time feedback, formative assessment; personal response from and engagement with academics: in essence, student-centered learning. Active learning is based on a theory of learning called constructivism, which emphasizes the fact that learners construct or build their understanding. The theory of social constructivism says that learning happens primarily through social interaction with others, such as a teacher or a learner’s peers. In constructivism, learners construct or build their own understanding of the learning. Learning in constructivism is a process of ‘making meaning’. Active learning was first defined by Bonwell and Eison [21] as “anything that involves students in doing things and thinking about the things they are doing”.

There are many benefits in active learning. Firstly, active learning builds both knowledge and understanding which students can then apply to new contexts and problems. Secondly, active learning fosters students’ learning and their autonomy, giving them greater involvement and control over their learning and giving them skills of life-long learning. Thirdly, active learning allows learners to develop their metacognitive thinking. It is generally acknowledged that students retain more knowledge when actively engaged in the
learning process, and active learning is often cited as an extremely effective instructional strategy [23,24].

2.1. Online Active Learning

Education is increasingly moving away from traditional face-to-face delivery to online learning. According to a prediction by Keegan [28] the e-learning global market will reach US$325 billion by 2025. Many believe that the market for e-learning will have threefold increase between 2020 and 2025. The COVID-19 pandemic has dramatically changed global education in the last two years. Because of the closure of schools worldwide, e-learning has become an essential element in supporting teaching and learning globally.

Despite the benefits, online active learning faces several challenges. One of these is because of the absence of non-verbal cues, compared with face-to-face active learning. Another is that online active learning requires a great deal more intrinsic motivation than a traditional face-to-face course. An important factor that relates to the transition from face-to-face learning is the attitude of learners towards active online learning. There are several factors that are important that affect the attitudes of the students’ learning. These include motivation, prior knowledge, computer skills/ICT Skills and learning preferences.

2.2. Factors Affecting Online Active Learning

There are factors that influence an online learner’s participation and patterns of participation such as technology and interface characteristics, content-area experience, students’ roles and instructional tasks [29]. However, for our study, we believe that the following factors are important for students when implementing active online learning: computer skills, motivation, prior knowledge and learning preferences.

2.2.1. Motivation

Motivation is defined as having a relation with action or movement [30,31]. In an educational context, motivation is used to explain the effort of students to invest in various activities although it is not the teacher’s desire. In online active learning, there is a need to ensure students are motivated before undergoing teaching and learning with online active learning. Brophy [32] defines motivation as “a theoretical construct to explain the initiation, direction, intensity, persistence, and quality of behavior, especially goal-directed behavior”. Motivation is the engine of learning [33]. It can influence what we learn, how we learn and when we choose to learn [34]. According to Ryan and Deci [35] motivated learners are more likely to undertake challenging activities, be actively engaged, enjoy and adopt a deep approach to learning and exhibit enhanced performance, persistence and creativity.

Motivation plays a crucial role in learning because it determines whether a learner persists in a course, the quality of work produced, and the level of achievement attained. Understanding what motivates students has important implications for learning, especially for online active learning. Ryan and Deci [35] argued that to be motivated means to be moved to do something.

Brophy [36] defined motivation as a theoretical concept that is used to explain the beginning, direction, force and insistence of goal-oriented behavior. According to Ryan and Deci [33], motivation is an attribute that instigates movements, an energy, direction, the reason for our behavior and “what” and “why” we do something. They categorized motivation as one of two types: intrinsic and extrinsic. Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, and without any external anticipation. According to these authors, challenge, curiosity, control, and fantasy are the key factors to trigger-up intrinsic motivation. In contrast, extrinsic motivation refers to doing something because it leads to a separable outcome.

Lepper et al. [37] argued that intrinsic motivation and academic achievement share significant and positive bonding. Intrinsic motivation directs an individual to participate in academic activities only to experience the fun, challenging and uniqueness without any external pressure or compulsion rather than expecting external rewards, gifts or under
any compulsion or pressure. Motivation also determines students’ will to pursue a task (even a difficult one) with enthusiasm or a lackluster attitude. It increases the initiation and persistence of activities and is an important predictor of learning and achievement.

2.2.2. Prior Knowledge

According to Posner and Rothbart [38], learning seemed to be most effective when learners were “tagging” new information to old knowledge, suggesting that prior knowledge and preconceptions are particularly important for teaching and learning. Prior knowledge is the most important factor influencing learning and student achievement [39]. It is defined as a multidimensional and hierarchical entity that is dynamic in nature and consists of different types of knowledge and skills [40]. Prior knowledge also positively influences both knowledge acquisition and the capacity to apply higher-order cognitive problem-solving skills [41].

For learning to occur, students must link new knowledge to previous knowledge in order to learn. When students can connect what they are learning to accurate and relevant prior knowledge, they learn and retain more. New knowledge ‘sticks’ better when it has prior knowledge to stick to. Relevant prior knowledge forms a framework for incoming information [42], allowing new materials to be integrated into a flexible knowledge representation that can be transferred to new situations [43,44].

Prior knowledge may help or hinder the student in learning, depending on the nature of prior knowledge [45]. Acquiring relevant information about the students and using it to design and validate the curriculum may help both the teacher and learner in the overall process [46]. According to Ambrose et al. [47], although prior knowledge generally facilitates new learning, there are four common prior knowledge conditions that can impede learning.

1. Insufficient prior knowledge;
2. Inaccurate prior knowledge;
3. Inappropriate prior knowledge;
4. Inert prior knowledge.

Students learn more readily when they can connect what they are learning to what they already know. However, instructors should not assume that students will immediately or naturally draw on relevant prior knowledge. Instead, they should deliberately activate students’ prior knowledge to help them forge robust links to new knowledge. Prior knowledge is very crucial to ensure the teaching and learning process runs smoothly. One of the major tasks of the teacher or educator is to observe the student’s early understanding on the topic or subject thought. This is important in order to encourage the students’ learning processes. It is well-known that students build on what they already know and have come to understand through formal or informal experiences [48]. Students develop attitudes and beliefs as they progress through life. Thus, it is important to assess prior knowledge early, since such information could be used to help foster student engagement in their learning process. According to Gee [48], there are few assessments that could be done to determine students’ prior knowledge i.e., use low-stake assignment or quiz or self-assessment of prior knowledge. These will help the educator or teacher to plan what to do next in their class. This is also important to encounter students’ misconceptions or misinterpretations. According to Aydin [49], misconception needs to be tackled, otherwise it will mislead students in their understanding of new knowledge. If misleading understandings continue to pile up, this will result in an incorrect and inappropriate interconnection of knowledge.

2.2.3. Computer Skills/ICT Skills

When we talk about online learning, success is inseparable from possession of sufficient computer skills. Nowadays, computers are used to do many things to help with our daily routines, and one of them is online learning. Learning online definitely requires computer skills that will help students with their learning activity, such as receiving and sending e-mails, searching for references and lecture notes, finding information, browsing
the Internet, doing assignments, participating in online discussion, collaborating with peers, writing assignment papers, and the list goes on. These activities definitely require the possession of basic computer skills by the student. Computer skills make a big difference in career development and growth [50]. According to Fauziah and Elnetthra [51] computer skills are important because they help students to sustain their motivation during online learning. Therefore, if students are good at basic computer skills then online learning will not be difficult for them and it can be more easily implemented.

2.2.4. Learning Preferences

At present, it is still open for debate what exactly learning preferences are. According to Kinshuk, Liu and Graf [52], the definitions of learning preferences are still unclear. Additionally, a comprehensive model which describes the most critical learning style preferences and the questions about the strength of learning style preferences are also uncertain. Jonassen and Grabowski [53] add that learning preferences are very much related to processing information in certain and specified ways. Another source adds that by categorizing students according to a number of levels concerning to the ways they collect and process information is itself distinguished as a learning preference [54]. In another definition, a learning-preference can be defined as the composite of cognitive, affective, and psychological characteristics that serve as an indicator of how an individual interacts with and responds to the learning environment [55,56]. Learning styles also can be described as the means of perceiving, processing, storing, and recalling attempts in the learning process [57]. Various cognitive and learning style theories and models have been proposed over the course of many years, identifying and categorizing students' individual differences, such as Hill’s Cognitive Style Mapping [58], Dunn and Dunn Learning Styles [59], Howard Gardner’s Multiple Intelligence Theory [60], Kolb’s Learning Styles [61], Gregorc Learning Styles [62], Felder-Silverman Learning Model [54], Grasha-Reichmann Learning Style Scales [63], and Hermann Brain Dominance Models [64]. These models of learning styles are currently being used to assess how students learn.

These attitudes i.e., motivations, computer skills, prior knowledge and learning preferences are important to ensure a successful active online learning activity. Motivation will boost students’ interest to engage more in their learning [65]; motivated students are more likely to take challenging learning activities and evince enhanced accomplishment, creativity and persistence [31]. Motivation can influence what to learn, how to learn and when we choose to learn [34]. Therefore, there is a positive relationship between motivation and learning [32] as students will be more focused on their assessment and will give effort to accomplish their tasks, whether it is individually or by groups [66].

Computer skills also play a critical part, especially when we talk about online learning. Students who did not formerly learn by computer will find it difficult to do assignments, difficult to participate in peer discussion or do any learning activities [10]. That is why students have to have some basic knowledge and competencies with computers before proceeding with online learning.

New learning is constructed on prior knowledge. A student may interpret things in his or her own way, a way distinct from the teacher’s or educator’s [67]. The more teachers or educators understand about what students already think and help them to engage their prior understanding, the more likely the students are to learn better—and the less likely students are to misinterpret the material in learning. That is why prior knowledge is very critical at the beginning, so that the teacher or educator can lessen the misunderstandings in teaching and learning. Learning preferences also need to be addressed because they are very much related to students’ flexibility of learning and resource-based learning [68].

Although there are many other studies conducted by researchers on the issues related to active online learning, it is our belief and experience that students’ attitudes at the beginning of their learning have an impact on their online learning [69]. Students’ attitudes such as motivation, prior knowledge, computer skills and learning preferences are important factors that would affect their learning. We believe that by identifying the attitudes of the
students on motivation, prior knowledge, computer skills and learning preferences at the start of their online learning enables us to design instructions that would promote better and more effective learning. Having identified the students’ attitudes at the start of their learning we would try to understand why the students had the attitudes and propose a framework based on neuroscience (the study of the human brain), that can help teachers how to design online learning that would improve active online learning for students.

3. A Brief Review of Neuroscience

According to Pellissier [70], traditional teaching strategies do not consider how a student’s brain works. Recent discoveries about brain-based learning are providing not only new insights to promote students’ learning, but also helping students to absorb and retain information. It is our belief that research from neuroscience provides many insights, understanding and improved approaches that we can incorporate into our online active learning based on the four factors that affect student’s attitudes and readiness of learning physics.

3.1. What Is Neuroscience?

According to Goswami [71], neuroscience is the study of the anatomy and physiology of the human brain, including its structures, neurons, and molecules. It studies how the brain works in terms of mechanics, functions, and systems to create recognizable behaviors [71]. Neurons in the brain are active components responsible for thinking, acting, and perceiving [72]. Neuroscience is the science of the brain and the nervous system. It studies how brain cells signal to each other, which chemicals they use; how they connect to each other by sending small electrical pulses; looking at connected activity in the visual areas of the brain, the auditory areas of the brain and the thinking areas of the brain. Neuroscientists also study how the brain evolved, how cells in the developing brain differentiate themselves visual versus auditory brain cells, and how brain cells know where in the brain to go to do their designated jobs.

There are many different branches of neuroscience—everything from computational, to pharmacological, to molecular neuroscience, cognitive neuroscience, educational neuroscience, and others. The neuroscience for learning is known as educational neuroscience.

3.1.1. Neuroscience Core Concepts

Neuroscience core concepts defined by the Society for Neuroscience [73] are:
1. The most complex organ in the body is the brain;
2. Both electrical and chemical signals are used by neurons to communicate;
3. The brain is the foundation of the nervous system;
4. The foundation of the nervous system are genetically determined circuits;
5. Life experiences change the nervous system;
6. Intelligence is the result of the brain’s reasons, plans, and solved problems.
7. The brain communicates knowledge through language.
8. The human brain enables us to understand how the world works.

Educators and schools around the world are increasingly applying neuroscience in their classrooms.

3.1.2. Educational Neuroscience

Educators and schools around the world are increasingly using the knowledge, techniques, and programs developed from this new understanding of how our brains learn. They are applying neuroscience in their classrooms. Educational neuroscience is based on the principle that understanding the neural mechanisms underlying learning may inform classroom teaching practice and policy [74]. The aim of neuroscience is to understand the workings of the brain and connected nervous system, the functional architecture of the mind, and how the brain and mind map work together [75]. Today we can explore the
functional organization of the human brain due to recent advances in development of brain imaging techniques such as electroencephalography (EEG), positron emission topography (PET) and functional magnetic resonance imaging (fMRI).

The attempt to connect neuroscience, cognitive science, psychology, and education have resulted in a fast-growing interdisciplinary field of study known as “Educational neuroscience,” “Mind, Brain, and Educational Science,” and “Neuroeducation” (see Figure 1) [76]. In this article, we would use the term education to signify enhancing learning, and neuroscience is about understanding the biological brain as well as mental processes are involved in learning. It is our belief that having a deeper understanding of how the brain works can help teachers plan lessons that teach students to enable them to learn effectively.

![Figure 1. The Emergence of Neuroeducation. Source: Interpretation of Tokuhama-Espinosa’s Transdisciplinary Field by Nakagawa [77].](image)

3.1.3. How Neuroscience Helps Learning

Based on the principles of neuroscience, teachers can help students to learn better. Firstly, we need to know how our students’ brains work and how learning happens in the brain; teachers can then design learning approaches that best help the students to learn effectively. Understanding how the brain works allows teachers to plan lessons and choose methods that align with neuroscience research for learning. Neuroscience can help us to understand what works and what does not. Secondly, neuroscience research helps to understand that the behavior of students is influenced by how the brain works and environment, genetics, and perceptions. Thirdly, neuroscience sheds light on important topics related to how the brain learns such as including neuroplasticity, memory, metacognition, mindfulness, retrieval strategies, reflection, motivation, and prior knowledge. Fourthly, neuroscience helps us to understand how students’ brains are affected by factors such as sleep, emotional, social encounters, and exercises in order to help us to choose the best help to give to students.

4. Methodology of Research

4.1. Case Study

Traditionally, physics is taught face to face in class and tutorials. Theory and practical classes are required to optimize students’ understanding of the subject. Teachers’ approaches to teaching physics are often ineffective, resulting in students finding learning difficult, resulting in a high dropout rate. Students who learn physics for the first time have negative shifts in beliefs about physics and learning physics [78]. Students with negative
beliefs will consider physics difficult [79] and beyond their capability to comprehend [80]. The difficulty in learning physics results in declining enrollment in physics by students either in the secondary school or university level [81,82]. The ways in which we teach physics are critical because they affect students’ interests and learning. Research has shown that traditional instruction resulted in negative shifts in students’ motivation and interest about physics and learning physics [78,79,83,84].

To address this problem, we have decided to investigate if we could take a different approach to teach physics using active online learning. Having discussed the matter with colleagues, we thought that online learning would help to motivate students to learn better because they could learn from home and at their own time and pace. However, learning physics requires active participation by students; this makes traditional online learning impractical. Hence the idea of active online learning was the ideal answer. But our students are used to face-to-face learning. We decided to investigate the attitudes of the students toward active online learning based on factors that we considered to be important such as motivation, prior knowledge, computer skills, and learning preferences. Our case study was to investigate students’ responses as to these attitudes before online active learning and post online active learning in a case study.

4.2. Methodology

A quantitative approach using survey was used to investigate the four factors, i.e., motivation, prior knowledge, computer skills, and learning preferences of the attitude of the physics students at Labuan Matriculation College in Malaysia. This case study was chosen because the students were new to online learning and also very apprehensive about the new approach to learning. It was important for us to find out as much as possible about the students’ attitudes toward online learning in order to help us design the course for students to learn better. A 5-point Likert scale questionnaire was distributed to a cohort group of undergraduates at the college before the implication of active online learning for the students. The study consists of two phases: pre-implementation surveys, post-implementation surveys, and interviews.

There were four hypotheses for the pre implementation and four after the implementation. The aim of the study was to determine what are the students’ attitudes in relation to factor such motivation, prior knowledge, computer skills, and learning preferences towards active online learning because these students had no online learning experience before.

The research used a hierarchical regression for data analysis across a sample of 24 (age 18–19 year old) young respondents who studied physics at Labuan Matriculation College i.e., pre-university in year one of their enrollment. A survey known as Students’ Readiness Learning Through Online, designed by Fauziah [85] was administered before and after the teaching and learning via PBL Online was implemented (that consist of the four elements, i.e., motivation, prior knowledge, computer skills, and learning preferences). The PBL online teaching and learning was administered by a facilitator who conducted the class throughout for 16 week of study period. The students were taught by the online PBL method for one semester i.e., 16 weeks and their participation was voluntary.

4.3. Participants and Procedure

The research was based on a survey which consisted of 74 items divided into three large groups, according to the predefined interdependencies and the questions derived from them. Questionnaires were distributed to 24 respondents located in Labuan Matriculation College, utilizing convenience sampling technique, as the method allows the researcher to control the representativeness of the sample. Respondents were pre-screened and restricted to Labuan Matriculation College students who had the same module or course in learning physics. Since the research was at its early stage, ethical approval was not required. Data collection was held from the early semester as pre-survey and again at the end of semester as the post-survey. Students were required to tick or circle the response which best described their level of agreement with each of the questionnaires’ items.
4.4. Questionnaire Development and Instrument

The structured close-ended survey was designed on the basis of the objectives of this study. The survey consists of two parts. The first part contained general demographic questions, relating to such matters as gender and age, while the second part comprised questions about the students’ motivation, computer skills, prior knowledge and learning preferences which comprised items for each construct that suit the context of the current research. Students were then required to rate their degree of agreement with the propositions in the questionnaire. This instrument was adopted from Survey of Students’ Level of Computer Usage in Learning and Students’ Readiness for Learning via Online Learning which was adapted to the Malaysian context by Fauziah [18].

4.5. The Online Learning Activity

After undergoing the pre-survey, students underwent a fully online active learning problem-solving process, following an online Problem-Based Learning instruction model that was introduced by Fauziah [18]. From this learning activity, students were given a problem scenario. Then, in a group of 4 members (total of 6 groups) the students were asked to do their own active independent learning process, i.e., coordinate tasks, find references, collaborate, discuss, and read more information about how to address the issue. All of these activities were done online i.e., e-mail, learning management system (LMS), Facebook, and WhatsApp. A trained teacher facilitated all the groups and gave feedback to all questions and inquiries asked by the groups.

4.6. Data Analysis

The completed and structured close-ended survey were coded and keyed in Statistical Package for Social Sciences (SPSS) computer program version 27, and descriptive analysis such as means, standard deviation, and correlation analysis were performed. Next, further investigation using hierarchical regression analysis was executed to assess the relationship between a set of independent variables and the dependent variable, controlling the impact of a different set of independent variables i.e., motivation, prior knowledge, computer skills, and learning preferences, on the dependent variable i.e., students’ readiness for online learning, which thereafter could support empirical findings in supporting the outlined study objectives.

4.7. Hypotheses of the Study

The hypotheses of the study are:

**Pre-implementation**

**Hypothesis 1 (H1).** The students’ computer skills have a significant relationship with the students’ readiness for online learning.

**Hypothesis 2 (H2).** The students’ learning preference style has a significant relationship with the students’ readiness for online learning.

**Hypothesis 3 (H3).** The students’ prior knowledge has a significant relationship with the students’ readiness for online learning.

**Hypothesis 4 (H4).** The students’ self-motivating learning has a significant relationship with the students’ readiness for online learning (pre-questionnaire).

**Post-implementation**

**Hypothesis 5 (H5).** The students’ computer skills have a significant relationship with the students’ readiness for active online learning (post-questionnaire).

**Hypothesis 6 (H6).** The students’ learning style has a significant relationship with the students’ readiness for active online learning (post-questionnaire).
Hypothesis 7 (H7). The students’ prior knowledge has a significant relationship with the students’ readiness for active online learning (post-questionnaire).

Hypothesis 8 (H8). The students’ self-motivating learning has a significant relationship with the students’ readiness for active online learning (post-questionnaire).

5. Results and Findings

5.1. Correlation Analysis

Pearson correlation coefficient was performed to measure the inter-correlation between variables (see Table 1). Correlation coefficient (r) value of $-1$ indicates a negative correlation and $+1$ indicates a positive correlation [86,87]. The multi-items for a construct were computed to produce an average score which was used in correlation analysis and hierarchical regression analysis. Table 1 shows that all variables significantly correlated with students’ readiness at 0.01 level. Among the independent variables, i.e., motivation, computer skills, prior knowledge and learning preferences, learning preferences has the strongest correlation coefficient value with students’ readiness ($r = 0.483$) and infers that students’ readiness is reliant on their learning style. On the other hand, computer skills ($r = 0.471$) also shows significant results. Computer skills play an important role in the students’ readiness to actively learn physics via online learning as well. The skewness of all the items ranges from $-0.246$ to $0.520$, below $\pm 2.0$. Similarly, the values for kurtosis range from $-0.615$ to $0.107$, far less than the cut-off value of $\pm 10$. Both the skewness and kurtosis are lower than the said value, thus ensuring that the data used in the study is normally distributed. Means for all constructs, as depicted in Table 1 range from 3.394 to 3.972 on a scale of 1 = strongly disagree to 5 = strongly agree, which infers that most of the respondents had positive intentions towards learning physics actively via online learning. The highest means appear for the computer skills construct.

Table 1. Relationships with students’ readiness and attitudes (i.e., Computer Skills, Learning Preferences, Prior Knowledge & Motivation).

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<tr>
<td>2. Computer skills (CS)</td>
<td>0.471 *</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Learning Preferences (LP)</td>
<td>0.483 *</td>
<td>0.371</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Prior Knowledge (PK)</td>
<td>$-0.229$</td>
<td>0.048</td>
<td>0.174</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>5. Motivation (M)</td>
<td>$-0.480$</td>
<td>$-0.041$</td>
<td>0.216</td>
<td>0.445</td>
<td>1.000</td>
</tr>
<tr>
<td>Mean</td>
<td>3.965</td>
<td>3.972</td>
<td>3.883</td>
<td>3.394</td>
<td>3.865</td>
</tr>
<tr>
<td>SD</td>
<td>0.377</td>
<td>0.605</td>
<td>0.514</td>
<td>0.440</td>
<td>0.597</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.404</td>
<td>$-0.246$</td>
<td>0.382</td>
<td>0.520</td>
<td>0.326</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>$-0.615$</td>
<td>$-0.493$</td>
<td>0.107</td>
<td>0.031</td>
<td>$-0.423$</td>
</tr>
</tbody>
</table>

Correlation analysis among variables; * significant at 0.01 level.

Pearson correlation coefficient was performed to measure the inter-correlation between variables (see Table 1). Correlation coefficient (r) value of $-1$ indicates a negative correlation and $+1$ indicates a positive correlation [64,65]. The multi-items for a construct were computed to produce an average score which was used in correlation analysis and hierarchical regression analysis. Table 1 shows that all variables significantly correlated with students’ readiness at 0.01 level. Among the independent variables i.e., motivation, computer skills, learning preferences, prior knowledge and motivation, learning preferences has the strongest correlation coefficient value with students’ readiness ($r = 0.483$) and infers that students’ readiness is reliant on their learning style–as stated in the paper.
5.2. Pre-Implementation

Proposed hypotheses are tested via hierarchical regression analysis as it allows examination of the effects of the moderating variable and the independent variables separately. Moderating variable is a moderator that can strengthen or weaken the relationship between an independent variable and a dependent variable. In this study, cooperative learning is the moderating variable. Results enumerated in Table 2 infer that all the independent variables have variance inflation factor (VIF) values ranging from 1.192 to 4.645 which is less than the cut-off point of 10, and tolerance values ranging from 0.215 to 0.839 which is above the threshold of 0.10, thus ensuring that multi-collinearity is absent.

Table 2. Pre-Survey of Relationships with students’ readiness of learning Physics via Active Online Learning and attitudes. (i.e., motivation, prior knowledge, computer skills, and learning preferences).

<table>
<thead>
<tr>
<th></th>
<th>Standardized β Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>Sig.</td>
</tr>
<tr>
<td>1 Computer skills</td>
<td>β₁ = 0.261</td>
<td>1.780</td>
</tr>
<tr>
<td>2 Learning Preferences</td>
<td>β₂ = 0.518</td>
<td>3.445</td>
</tr>
<tr>
<td>3 Prior Knowledge</td>
<td>β₃ = −0.091</td>
<td>−0.599</td>
</tr>
<tr>
<td>4 Motivation</td>
<td>β₄ = −0.541</td>
<td>−3.510</td>
</tr>
</tbody>
</table>

* shows significant value at \( p < 0.05 \).

In step 1, the independent variables i.e., computer skills, learning preferences, prior knowledge and motivation, were analyzed. \( R^2 \) provides information about the level of fit of the regression model and elucidates the percentage of variance in students’ readiness of learning physics via active online learning that can be accounted for by all the predictors. Then, in step 2, the hierarchical regression analysis, cooperative learning was entered and allowed the examination of any increase in explained variance to determine the effect on students’ readiness of learning physics via active online learning.

The results of the estimated coefficients as detailed in Table 2 shows that both motivation (\( β₄ = −0.541, t\)-value = −3.510, \( p = 0.002 < 0.05 \)) and learning preferences (\( β₂ = 0.518, t\)-value = 3.445, \( p = 0.003 < 0.05 \)) significantly influence the students’ readiness of learning physics using active online learning during the pre-implementation. Therefore, H2 and H4 are reinforced. However, computer skills (\( β₁ = 0.261, p = 0.091 > 0.05 \)) and prior knowledge (\( β₃ = −0.091, p = 0.556 > 0.05 \)) have insignificant relationship with students’ readiness of learning physics via online learning; thus H1 and H3 are not sustained.

5.3. Post-Implementation

Results enumerated in Table 3 infer that all the independent variables have variance inflation factor (VIF) values ranging from 1.160 to 3.645, which is less than the cut-off point of 10, and tolerance values ranging from 0.315 to 0.685, which is above the threshold of 0.10, thus ensuring that multicollinearity is absent.

As above, in Step 1, the independent variables i.e., computer skills, learning preferences, prior knowledge and motivation, were analyzed. \( R^2 \) provides information about the level of fit of the regression model and elucidates the percent of variance in students’ readiness of learning physics via active online learning that can be accounted for by all the predictors. Then, in step 2, the hierarchical regression analysis, cooperative learning was entered and allowed the examination of any increase in explained variance to determine the effect on students’ readiness of learning physics via active online learning.

The acceptance of the hypotheses of the study are:

**Pre-implementation**
Table 3. Post-Questionnaire of relationships with students’ readiness of learning physics via active-online learning and attitudes (i.e., Motivation, Computer Skills, Prior Knowledge and Learning Preferences).

<table>
<thead>
<tr>
<th>Standardized β Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Computer skills</td>
<td>β₁ = 0.670</td>
<td>1.580</td>
<td>0.008 *</td>
<td>0.685</td>
</tr>
<tr>
<td>2 Learning Preferences</td>
<td>β₂ = 0.413</td>
<td>2.466</td>
<td>0.007 *</td>
<td>0.576</td>
</tr>
<tr>
<td>3 Prior Knowledge</td>
<td>β₃ = −0.322</td>
<td>−0.457</td>
<td>0.004 *</td>
<td>0.625</td>
</tr>
<tr>
<td>4 Motivation</td>
<td>β₄ = −0.651</td>
<td>−3.919</td>
<td>0.003 *</td>
<td>0.315</td>
</tr>
</tbody>
</table>

* shows significant value at p < 0.05.

Hypothesis 1 (H1). The students’ computer skills have a significant relationship with the students’ readiness for active online learning (pre-survey). Hypothesis H1 is rejected, Computer skills have not significantly influenced the students’ readiness for learning physics using active online learning during the pre-implementation.

Hypothesis 2 (H2). The students’ learning preferences have a significant relationship with the students’ readiness for active online learning (pre-survey). Hypothesis H2 is accepted, Learning preference significantly influenced the students’ readiness of learning physics using active online learning during the pre-implementation.

Hypothesis 3 (H3). The students’ prior knowledge has a significant relationship with the students’ readiness for active online learning (pre-survey). Hypothesis H3 is rejected, Prior knowledge has not significantly influenced the students’ readiness of learning physics using active online learning during the pre-implementation.

Hypothesis 4 (H4). The students’ self-motivating learning has a significant relationship with the students’ readiness for active online learning (pre-survey). Hypothesis H4 is accepted, Self-motivation significantly influenced the students’ readiness of learning physics using active online learning during the pre-implementation.

Post-implementation

Hypothesis 5 (H5). The students’ computer skills have a significant relationship with the students’ readiness for active online learning (post-survey). Hypothesis H5 is accepted, Computer skills significantly influenced the students’ readiness of learning physics using active online learning during the pre-implementation.

For the post-survey, the results of the estimated coefficients as detailed in Table 3 show that all four elements; i. computer skills (β₁ = 0.670, t-value = 1.580, p = 0.008 < 0.05); ii. learning preferences (β₂ = 0.413, t-value = 2.466, p = 0.007 < 0.05); iii. prior knowledge (β₃ = −0.322, t-value = −0.457, p = 0.004 < 0.05); and iv. motivation (β₄ = −0.651, t-value = −3.919, p = 0.003 < 0.05) significantly influenced the students’ readiness of learning physics via online learning during the post-implementation. Therefore, H5, H6, H7 and H8 are reinforced.

It is important to understand each of the hypotheses based on principles from neuroscience. We will try to give reasons for the post implementation attitudes of the survey and interviews.

Computer skills also play a critical part, especially when we talk about online learning. Students who did not previously learn by computer will find it difficult to do assignments or to do any learning activities [18], difficult to participate in peer discussion or do any learning activities. That is why a student has to have some basic knowledge and competencies with computers before proceeding with online learning.

Students with computer skills did not have to learn about how to use the computer, but were able to focus on learning the content instead of the tool. The actions of using
the computer would be automatic rather than conscious having to pay attention to it. Computer skills influence attitudes towards online learning. According to Shashaani [88], empirical studies have shown that ICT skills are positively related to computer attitudes”. Woodrow [89] also points out that “awareness of student attitudes towards computers is a critical criterion in the evaluation of computer courses and in the development of computer-based curricula”.

According to Michelon [90], neuroplasticity, or brain plasticity, is referred to the brain’s ability to CHANGE throughout life in its activity in response to intrinsic or extrinsic stimuli by reorganizing its structure, functions, or connections. Our brain can reorganize itself by forming new connections between brain cells (neurons). These changes occur between neurons at the level of connections during learning. These connections become stronger the more we practice our activities such as using the computer. Kania et al. [91] argued that as the connections strengthen, the messages (nerve impulses) are transmitted increasingly faster, making them more efficient. But when we stop practicing the activities, the connections between the neurons weaken and are eventually removed. Practicing or rehearsing repeatedly activates your neurons and makes you learn.

Hypothesis 6 (H6). The students’ learning preference style has a significant relationship with the students’ readiness for active online learning (post-survey). Hypothesis H6 is accepted, Learning preference style significantly influenced the students’ readiness of learning physics during the active online learning course.

Regarding learning styles or preferences, for those of us who believe that learning styles affect learning, this is a myth because we have fallen prey to a popular myth and misconception about the brain and its functioning [92,93]. It is important that we should consider designing for the brain and not the learning style. It would be more useful to think about learning modalities or learning preferences rather than talking about learning styles. These learning preferences can make a big difference in how open an individual is to learn about a new topic. When an instructor is considering how to split up a 50-minute class meeting, or a student realizes they’ve reread the same paragraph over and over again and still doesn’t grasp the meaning, consideration of different learning modalities could provide important new perspectives that might help the new information “click”.

Hypothesis 7 (H7). The students’ prior knowledge has a significant relationship with the students’ readiness for Active online learning (post-survey). Hypothesis H7 is accepted, Prior knowledge significantly influenced the students’ readiness of learning physics via active online learning during the pre-implementation.

After undergoing active online learning, students responded that it is essential to have basic knowledge or fundamental knowledge of optimizing active learning online. At the same time, prior knowledge of the content, e.g., physics, is significant for them as this promoted meaningful discussions amongst them and help them to learn. Students felt that prior knowledge was critical for them to have so that they could link new knowledge to prior knowledge.

The authors concur with Howard-Jones [94] that it is important to understand the role of prior knowledge for students to learn effectively. Howard-Jones [94] argued that understanding educational neuroscience can help us to improve how prior knowledge has implications for student learning. Two areas of the brain are important for knowledge construction. According to Brod et al. [95], the two areas are the medial prefrontal cortex (PFC), which helps to detect the fit of incoming knowledge with what is already known and to retrieve this prior knowledge, and the lateral PFC for the processes of connecting new incoming knowledge with this prior knowledge, as shown in Figure 2:
Hypothesis 8 (H8). The students’ self-motivating learning has a significant relationship with the students’ readiness for online learning (post-survey). Hypothesis H8 is accepted. Self-motivation has significantly influenced the students’ readiness for learning physics via online active learning during the pre-implementation.

Although students found learning alone was difficult and challenging, the tasks given to them pushed them to find related information and link them from one to another. Working in groups helped to stimulate their learning. This was because discussion and sharing enhanced their skills and helped to promote new ideas.

Motivation is the key to success for effective learning. It makes the difference between success and failure in learning. According to the principles of neuroscience, Dopamine, is a neurotransmitter that carries signals from one neuron to another in a specific route of our brain to energize thoughts. It is a key chemical involved in almost every aspect of motivation. Dopamine affects some well-known ‘regions of the brain’, the Hippocampus (memory formation) and the Amygdala (emotional regulation) as well as the Prefrontal Cortex (PFC), which is responsible for decision-making, controlling behavior and recognizing reward. There is an increased flow of dopamine to these parts of the brain when one feels a great drive to initiate or finish a task. Increased dopamine can improve other mental processes, including memory, attention, perseverance, and creative problem-solving.

It is necessary to make a distinction between intrinsic (internal) and extrinsic (external) motivations to understand while there is increase dopamine flow almost automatically in some situations and not in others. Intrinsic (internal) motivation is an internal process that applies to tasks that one is genuinely interested in and value as extremely relevant to life. Conversely, extrinsic (external) motivations are concerned with any external factors that might be driving one to do something, such as expectations from peers or family.

5.4. Guidelines for Teachers to Implement Active Online Learning

Our study found that motivation, prior knowledge, computer skills and learning preferences have positive influence for students in active online learning. We have derived the following guidelines based on principles from neuroscience that can be used to help teachers to promote and improve motivation, prior knowledge, computer skills and learning preferences in their active online teaching.

A great deal of the scientific research and academic dialogue related to brain-based learning has been focused on neuroplasticity—the concept that neural connections in the brain change, remap, and reorganize themselves when people learn new concepts, have new experiences, or practice certain skills over time. Scientists have also determined, for example, that the brain can perform several activities at once; that the same information can be stored in multiple areas of the brain; that learning functions can be affected by diet, exercise, stress, and other conditions; that meaning is more important than information when the brain is learning something new; and that certain emotional states can facilitate or impede learning—among many other findings. The following guidelines can
be used to help teachers to implement active online learning based on principles from educational neuroscience.

5.4.1. Computer Skills

The post-survey shows us that having computer skills significantly influenced the students’ readiness of learning physics using active online learning.

Research from neuroscience shows that practicing a slightly modified version of a task we want to master, we learn more and faster than if we just keep practicing the exact same thing multiple times in a row. This is due to reconsolidation, a process whereby existing memories are recalled and modified with new knowledge [92]. To help to improve computer skills, it is advisable to develop novel behavioral interventions and training schedules that give people more improvement for the same amount of practice time. Everything we learn goes first to our short-term memory. Some of it may transfers later to long term storage in our brain. Sleep is important to transfer information from short to long term memory, which is why memory loss can occur with sleep deprivation. Because memories must travel across many synapses and neurons, degradation often occurs that can render memories incomplete once they are transferred. It is important to encourage students to have adequate sleep to learn effectively. To help students to improve online learning it is imperative that students are trained and well prepared in their computer skills before embarking the online course.

5.4.2. Learning Styles or Preferences

The best approach is to use the best modality or modalities for the content. People learn new material best when they encounter it multiple times and through multiple modalities. Since different modalities activate different parts of the brain, when students encounter new material in many different ways, they’re in a better position to make more sense of the material.

5.4.3. Prior Knowledge

To facilitate learning, it is important to help students to retrieve prior knowledge. Howard-Jones [94] argues that the following processes must be involved for effective teaching and learning. Firstly, we must engage the learner’s attention. Secondly, teachers must guide the building of knowledge and understanding. Thirdly, learning must be consolidated through application, practice, and reflection. He furthers argues that a two-way flow of information is needed to help students grasp new concepts. This involves clear communication by the teacher of concepts, but also communication by the student of what they are beginning to know or know already, i.e., through their questions, answers, homework, classwork, etc. All future learning must build on prior knowledge [94]. Relevant information also needs to be active at the time of learning. Having teachers review relevant material may also create the illusion of active prior knowledge. Rather, retrieval practice in the form of a short questionnaire on the required knowledge can be used as effective preparation for the learning, as well as a source of formative assessment for the teacher to understand whether students have retained relevant information. The connections between the new concepts and existing knowledge should be explicit. It is, therefore, important that students are prompted to re activate appropriate prior knowledge e.g., revision question-and-answer before new information is presented, and that the student is then encouraged to make connections between the new information and their existing knowledge. As well as learning new information, a student must also learn how to apply it. Applying new information requires using prior knowledge to transform, organize and elaborate the new input. In order to ensure that students are able to make meaningful connections between concepts by deeply understanding the concepts, it is important to use multiple concrete examples and make explicit links between them, explaining the features they have in common. Some other useful strategies to activate prior knowledge include
pre-assessments, advance organizers, essential questions, concept maps, graphic organizers, and “hook” activities.

5.4.4. Motivation

Research from neuroscience shows that it is possible to promote motivation by creating the dopamine environment. Setting incremental goals is a useful approach for dopamine flows because of the brain’s positive reinforcement every time a step is complete and meet a challenge [96]. This can be achieved by using the following steps:

• Focus on one task at a time;
• Focus on the achievement you will feel when you completed a task;
• Focus on small tasks;
• Share your results with others;
• Regularly ask students questions;
• Use online quizzes;
• Set goals and help your students stick to them;
• Set aside time for self-reflection;
• Encourage collocation by making students work in groups;
• Make learning fun and interesting;
• Recap what was covered in the previous class.

6. Discussion

This research examined the attitudes of students’ responses to motivation, prior knowledge, computer skills and learning preferences before active online learning and post-active-online learning in a case study. In active online learning, students must do something to develop their skills, as opposed to passive learning, where information is merely transmitted to them. An important factor that relates to the transition from face-to-face learning is the attitude of learners towards active online learning. Having this knowledge would help teachers to develop and apply appropriate models and forms of online learning to meet the students’ needs. One of the important factors for this transition is the attitude of learners. Learner attitude plays an important role for online learning, [10]. According to researchers [12,13], learners’ attitudes and perspectives towards online learning are a key factor for their learning outcomes. Lim et al. [14] argued that students’ positive attitudes towards online learning are critical to their readiness and their inclusion in online learning.

At the first phase, before implementation of the online course, students’ responses to the attitudes of the four factors that they believed that learning preferences and motivation play important towards their active-online learning as supported by Geng et al. [97] indicated that prior knowledge and computer skills did not have much influence toward their active online earning.

The pre-implementation survey shows students believed only two factors would affect their learning. However, the post-implementation survey shows different results. From the post-interviews we found that all four factors were considered important that would affect their active online learning.

The students’ computer skills have a significant relationship with the students’ readiness for active online learning (post-survey). According to research in neuroscience, we perform better when we practice a movement repeatedly, partly because we develop new motor memories, or representations, in our brains. We will not perform better if we cannot store motor representations in our brains. Motor adaptation is the creation of better and better motor representations as we practice a movement. Like our memories of people and events. Motor representations are formed and stored in the brain. Familiar movements, like typing when using the computer are located in a part of the brain called the left parietal lobe. Neuroscience scientists believe that when we practice, we develop motor representations. These representations or memories are created by groups of brain cells that interact to help
us perform a movement we have learned. This memory is flexible and can be replayed to make movements in different situations.

The students’ learning preference style has a significant relationship with the students’ readiness for active online learning (post-survey). Learning happens when students encounter the same information through a variety of modalities, rather than only being approached through one method (only listening, only reading, or only doing, for example). And if learners prefer one modality over another, and they always give preference to that modality, then they may be missing out on opportunities to see information in a new way.

The students’ prior knowledge has a significant relationship with the students’ readiness for active online learning (post-survey). According to Howard-Jones [96], based on the principles of neuroscience, it is important for teachers to be aware of students’ prior knowledge because this is the foundation on which the students’ new knowledge will build. Teachers should encourage students to make connections with their prior knowledge to help students think meaningfully about new ideas. Because the brain is multisensory, teachers must have clear, concise instruction using all the senses, aiding communication and understanding of new knowledge, encouraging students to make links between different representations. From the neuroscience perspective, we should use our mirror neuron system because gestures and faces communicate knowledge and emotions, both consciously and unconsciously, supporting the teacher’s transmission of concepts, confidence, and enthusiasm.

The students’ self-motivating learning has a significant relationship with the students’ readiness for online learning (post-survey). Motivation plays a crucial role in determining whether a learner continue in a course, the level of engagement shown, the quality of work produced, and the level of achievement attained. It is therefore important to understand the nature of motivation and the ways in which personal histories, social factors, experiences and circumstances may influence the motivation of learners. Thus, it has important practical implications for active online teaching and learning.

Research from neuroscience shows that dopamine plays a big part in generating positive motivation and negative motivation depending on where in the brain it acted. High levels of dopamine in one area of the brain drove people to want to work hard for a reward; high levels in another drove them to reject that work. It is our belief that understanding how dopamine impacts students’ motivation can help students to increase motivation to better achieve their learning.

Our study found that students who actively engaged in an active online learning contributed to lively discussions between themselves and this in turn contributed to students’ motivation. It is important to understand why the four factors are important from the neuroscience perspective regarding how our brain learns so that we can design better active online learning that will promote students’ learning.

7. Conclusions

This study set out to investigate if the four factors, computer skills, learning preferences, prior knowledge, and motivation, affect students’ attitudes toward their active online learning in physics. The two phases of the study show that students’ attitudes changed in the post-implementation phase. During the pre-implementation phase, students considered learning preferences and motivation as the two factors that they believed would affect their learning. However, after the implementation, their attitudes changed. Post-implementation findings showed that all the four factors were important. This is not a surprise because computer skills are necessary to enable students to carry out online learning tasks. Students without these skills would have to learn them and they would be distracted from the learning of the subject. Although students were not aware of the importance of prior knowledge, they would soon realize that without prior knowledge they would have difficulties understanding the new concepts taught to them. This would mean going back to basics to learn the prior knowledge first. Prior knowledge is fundamental to all learning. Learning only happens when one can link the learning to knowledge
already learned and stored in memory. Having prior knowledge would help students to link concepts and understand them better. Having identified the attitudes of the students, it is important to understand why these four factors affect their learning. Principles from educational neuroscience can shed light to help us to understand the reasons. Educational neuroscience empowers teachers with a new understanding about how students learn. It sheds light to our understanding of various factors—computer skills, learning preferences, prior knowledge, and motivation and that influence the transformation of sensory information into networks of durable long-term memory and conceptual understanding.

Research from neuroscience is beneficial for active online learning because distinct neural systems related to executive functions such as planning or predicting, attention and object processing are dynamically activated and communicate with the hippocampus, enhancing its performance. It is our strong belief that applying neuroscience principles to active online learning can lead to higher levels of engagement, content retention motivation and better learning. It is therefore important that we understand neuroscience because the brain is our primary tool for learning. The brain is the core of human thought, memory, consciousness, and emotion. Thus, it makes sense to align online session design with how the students’ brain functions and connects with an online experience.

It is our belief that this study provides insights to factors that have implications for active online learning. These four factors are important from the neuroscience perspectives and teachers are wise to understand them and design learning that will promote these four factors for active online learning. We have included some guidelines based on the principles of educational neuroscience that can be used by teachers to implement active online learning.

The key limitation of this study is the small sample size. Despite this, it was necessary that we find out the students’ attitudes before implementing the online course because we want to help the students to learn better. We know that the sample of the studies is small, but we believe that despite the small sample, the lessons learned have important implications for designing active online learning. It is our belief that neuroscience can provide many insights into how we can motivate students to do active online learning, provide learning to suit the ways students learn, help students to equip themselves with the computer skills they need to carry out online learning, and provide ways to activate prior knowledge based on the principles of neuroscience. We are currently developing a brain-based learning model for on-demand learning to help teachers to meet the increased use of online learning in the post-COVID-19 era.


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