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Psychology of affect

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Abstract
Emotions form the composition of both our internal as well as our external environments. Emotions therefore play a role in every experience that we undergo; including the experience of learning. Studying the genesis of and role of emotions is the first foundation in understanding how emotions affect and direct our experiences; and in particular the experience of learning mathematics. The origin of emotions and their role in our survival will therefore be related to learning in general and mathematical learning in particular. In the study of emotion-mathematical learning experience, several theories have been proposed and studies carried out, to aid an adoption of an effective learning process for mathematical learners. These have been explored in this paper. Possible weaknesses of these models have also been explored. Ultimately, a possible relation between emotion, cognition and motivation has been analyzed. An effort to understand emotion as the first stage towards formation off attitudes and finally our beliefs; that define who we are in the end (which determines our success in mathematics) has been considered.

Keywords: Green computing, eco-friendly technology, carbon emissions, carbon foot print, e- waste, degradation

Introduction
Mathematics has embedded itself so much into our society than we may ever know. This is evident by the technologies that we have adapted through the use of computers, the internet, and telecommunications among many others. The knowledge of mathematics has helped us to develop many innovations that have made our lives not only easier but possible as well. While the discipline of mathematics may be thought as the preserve of scientists and mathematicians, its usefulness and applicability has enabled it to cross many other professional areas. This paper explores how emotion affects the learning and development of mathematics-affect psychology. It critically explores how emotional theories on mathematical learning have been applied by psychologists. By understanding how emotional psychology affects the learning of this crucial discipline, we can then see how to promote the same in a more knowledgeable way.

Background
Role of Mathematics in the Society
Many attempts have been made to comprehensively understand man's cognitive abilities. Several researchers have developed theories in an attempt to explain the human learning behaviour. This researched has over time specialized to specific areas including mathematical learning. As one may think, understanding human psychology may prove to be a difficult task considering that the psychology of man is a summation of very many parameters that are interrelated in a very complex relationship. Researchers have therefore come up with diverse explanations on the contribution of emotion stimulus in mathematical learning. Even with no single accepted theory on the role of emotion in mathematics cognitive capacities, it is obvious that considerable progress has been made in this research. For example, though the human mind may be functioning in a manner that is more complex, the computer is a primitive imitation to the human mind. It has an electronic memory and can perform tasks that require organized analysis including computation. It is highly probable that the innovators of the computer were either consciously or unconsciously motivated by understanding; in part how our minds operate. The obvious and especially important difference that is apparent here is that: unlike the computer, we react to emotional stimuli. This in turn affects our learning capacities. Understanding how this in particular affects learning of mathematics is the primary aim of this paper.

Nature of emotion

What is emotion? One thing we know is that emotions define the way we picture our environment (Walsh, 2005) [13]. They are responsible for creating a concept of understanding directed to our mind through our senses (Walsh, 2005) [13]. Considering that emotions have been ingrained into us to guard our survival, they take first consideration in the processing of response from our brains (Walsh, 2005) [13]. As we have all experienced repeatedly, although emotions are felt within short time durations, their impact forever alters the chain of how we understand the environment and ourselves (Bower, 1992) [2].

The above is general way of understanding emotion. To specifically understand the role that is played by emotion in learning, I will consider the theory of development as has been advanced by many researchers including Bower. Here, It is argued that emotions evolved in organisms as a way of enabling them to detect both their internal and external environmental environments as being either helpful or harmful to them (Bower, 1992) [2]. Since all humans have hope and plans to achieve their hopes, an environment is measured against these hopes and plans as either harmful or helpful to man (Bower, 1992) [2]. A dual taxonomy of determining our actions exists. On the top hierarchy, our inherent needs as a result of our biology and our determination to achieve these needs paint our actions (Bower, 1992) [2]. On the second hierarchy, our social desires at well as our cognitive desires and, our desire to achieve the same paint our actions (Bower, 1992) [2].

A goal inspired organism therefore needs to be embedded with the following components to survive. First, it needs not only to detect its needs but also needs to evaluate how urgent such needs are need to be satisfied. Secondly, the organism needs to have a system of ordering these needs in priority (Bower, 1992) [2]. Besides, It is very important for the organism to poses a program of planning that can either use; a previous method that had been applied; or come up with a new method of planning which will enable the organism to tackle its urgent needs (Bower, 1992) [2]. Here, a system of controlling one's attention is desired to ensure that the most urgent desire that most requires one's attention receives minimal competition from other desires. A memory that is working is also desired to enable the organism monitor the progress made in handling its desires (Bower 1992) [2]. It is also important for the organism to possess a means of detecting its internal as well as its external environment with an aim of detecting important needs that may cause it to stop its current corrective measures, to meet a more important need (Bower, 1992) [2].

Let me now move to interesting waters in an effort to explain how our emotions result. As we have seen above, parameters in our environments determine our reactions. A program of dealing with a most urgent priority is developed and monitored. It is obvious that our environment keeps changing in a way that cannot be predicted. New needs in turn arise and can be given priority over the ones that are prevailing depending on how important they are to us (Bower, 1992) [2]. Our emotions develop from output signals that are fed to our knowledge by a system that monitors the progress that has been made in meeting our needs of most priority (Bower, 1992) [2]. For example, emotions of anger may result; when a corrective plan is halted or is threatened by an enemy (Bower, 1992) [2]. Likewise, emotions of sadness may result when our corrective plans do not succeed in meeting goals (Bower, 1992) [2].

Effect of emotion on general learning

Since emotions are available in any kind of a learning setting, their role in affecting learning is significant. Well trained and experienced tutors may be interested to create those kinds of emotions that positively inspire learning. This may include using tone variation, creating a friendly environment with their learners; that encourage the stimulation of positive emotions among other methods. Motivation is thus applied to aid in learning. Although I will touch on the area of motivation more elaborately later on, I will mention here that it can importantly be inspired in the following ways. In one way, the student can be convinced that; learning the subject is of interest to achieving his / her goals and is therefore of importance. Once the learner views the area of learning in this manner, it becomes part of his / her needs inspiring a corrective mechanism in his system to attain the goal of learning the subject. I will mention on another way of motivation after considering the model described below.

Several models have been developed to describe the monitoring system. Researchers like Bower & Cohen, Fridja & Swagerman among others have specified emotional determinants as a series of rules that interpret external conditions to map them into appropriate emotions (Bower, 1992) [2]. When a certain emotion has been activated, our system will act to develop a corrective plan that can be either retrieved from our memory or developed anew (Bower, 1992) [2]. In another way, the instructor can encourage the learner develop a positive kind of thinking on his learning abilities; hence avoiding the absorption of parameters in the student's surrounding environment; like discouragement, which may stimulate negative reactions that may discourage learning. This is especially true considering that our systems have a system of monitoring the progress in achieving our goals; directly contributing to the kind of emotions that we experience in turn. As I will elaborate further on, emotions themselves play a comparatively significant role in the learning process.

Most researchers agree that our capacity to remember an event is dependent on the attention that was given to the event (Bower, 1992) [2]. Our memory can be described as relational in the sense that; we are able to remember by relating an aspect to existing aspects in our memory (Bower, 1992) [2]. The attention that is normally given to an event depends on how the event may be interesting to us (Bower, 1992) [2]. Bower (1992) [2] postulates that the two parameters that determine the level of interest to an event are: the level of unexpectedness to the occurrence of the event and the level of stimulating our emotions by the event. Considering that aspects in our memory are prioritized by our emotional stimuli, our emotions play a significant role in our capacity to remember hence learning. It is therefore possible to exploit emotional reactions to advance learning.

Studies like those by Brewer (2000) [3] confirmed the role of emotions in remembering. This was observed when his students were given materials to read and rate. Contents in the readings that were emotional affected the students in the following ways depending on their level of strength. One, they could stop the loop of events that had been stored in their memory by preceding events (in the material that was being read). They could also bias the current emotional event and could negatively affect the attention given to

previous events. Indeed, as we have all experienced, we tend to remember more autobiography contents largely because the experiences that have been shared by the writers excite our emotions. Likewise a romantic novel is more likely to be easily embedded in our memories than a scientific handbook: considering that the events in the novel are more likely to excite our emotions and subsequently inspire interest.

Since memory is directly responsible for storing any data as well as any information within us, there can be no learning without memory. Whether it is formulas, concepts, computational capabilities and coordinating, or the use of a monitoring system, it is stored in our memory (Knol, 2008) [7]. The fact that our memories are a product in partiality from our emotions shows how emotions are of significance in learning. To emphasize this even further, we need to view not only the singular effect of a particular emotion but the possible cumulative effect of this kind of emotion when it interacts with other emotions and other factors that affect learning over time to form a pattern that determines learning in the long run.

Effect of emotion on mathematical learning

So far, I have talked about learning in a general way. I will now focus on how emotional psychology is related to mathematical learning in particular. Although I will not generally deviate from the foundation that I have lain from the above theory; and will not therefore be saying anything new. I will concentrate more on mathematical learning. Having mentioned the role of emotion in remembering hence learning, the role of emotions in mathematical learning can already be seen. As I had mentioned, even computational capacities that are often consulted when solving a mathematical calculation largely relies on stored procedures that are in our memories. The process of calculation is also monitored by a program which behaves in a way that is similar; to the one that monitors our corrective plans which alter our emotions, which I had talked about earlier.

To understand mathematics better, we need to go further from the actual problem solving action itself. As Schloeglmann and Maasz have argued, the understanding of mathematics needs to be broadened. We need to also emphasize on non-procedural mathematics, cultural as well as social components of mathematics among others. Mathematics therefore interacts with many aspects that may alter our emotional wellbeing related to learning in general. For example, the computer has embedded so much with mathematics that it is only possible to understand some areas of mathematics with computer knowledge (Schloeglmann *et al*., 2006) [11]. I will not go into the details of how the learning of other areas directly affects mathematical learning since I have considered how emotions affect our learning capacity in general.

A challenge that has hindered comprehensive study of the affect psychology has been in the difficulty to accurately measure emotional components that in turn determine affect psychology (Leder, 1992) [8]. One area where affective psychology research has been considerably successful has been in addressing disparities in mathematical performance; that result across gender lines (Leder, 1992) [8]. The results from these studies have reinforced the belief that individuals have varying needs; which in turn determine the emotions that they experience; which consequently affect mathematical learning (Leder, 1992) [8]. This approach has at least helped us understand some aspects of affect psychology; particularly the fact that we all have different needs hence the need of a learning system that favors someone at the individual level while learning mathematics.

The key in understanding this research is to identify males as a group with some variations in their environmental needs; hence the emotions that they experience from their female counterparts. Initial research on mathematical gender carried out in the 1980's concluded that disparities in mathematical performance were primarily caused by the following: differences in opportunities to acquire education across gender, gender based biases in mathematical teaching and unfavorable social conditions for females (Leder, 1992) [8]. Many efforts were thus adopted to empower women in mathematics by removing disparities, including teaching methods that are gender friendly among other efforts (Leder, 1992) [8]. With time however, differences between as well as within genders became more recognized (Leder, 1992) [8]. A new approach was thus applied emphasizing on these differences. Unlike the initial approach, the nature of mathematics was skeptically analyzed; as had been proposed by previous generations which were dominated by males. Methods were thus developed to encourage understanding mathematics in different ways, tailored according to one's beliefs, values and abilities (Rogers *et al*., 1995) [10]. It is now apparent that it was damaging to compel learners understand mathematics in a single manner. This is because people have varying needs; hence varying emotions that affect their learning in different ways.

As can be seen, the above study differentiated the sample first basing on gender and then differentiated further into even smaller groups based on variations in needs; hence variations in emotional stimulus. The advantage in using such approach would be to escape the difficulty of primarily using data from measurements of affect as the most important data; since this is difficult to obtain. However, we still need to measure affect at least to some extent; in order to establish a relationship. A common approach that is utilized in measuring affect is to use affect that is both stable and easy to measure (Hannula, 2000) [6]. A relationship can thus be established between these affect measurements and mathematical success (Hannula). Hannula (2000) [6] carried out surveys to determine the relationship between attitude affect and mathematical success. Analysis of data suggested a proportional relationship of mathematical success to attitude.

Of interest to researchers has also been the general relation between affect and success. Chapman *et al*. (2000) [4] noted a possible relation between self-ego and success. A relation has also been suggested between ego and gender. This may explain the advantage of males in mathematics when compared to females. However, these studies have not been satisfactorily confirmed. Moreover, they do not recommend any mitigation that can be applied to boost success. This area will however be explored further; when a possible chain of emotional pattern resulting from a single emotion is considered.

Considering analysis models

I think that; analyzing the situation correctly and obtaining a comprehensive relationship would entail developing a model that incorporates very many parameters that are interrelated in a very complex scenario. A suggestion for

example is that in a general way, there is a relation between self-ego and general success; hence, even mathematical success. The question would then be how success in other spheres of life enhanced by a good self-concept for example affects other areas of development that in turn determine mathematical success. This is especially considering that mathematics is more than just mere calculations because it embeds with many other areas like culture. The challenge would then be to establish a model that borders as close as possible the real circumstances. This would aid in acquiring a more conclusive relationship, as well as identify possible remedies to negative affects; which hinder success in general, and success in mathematics in particular.

A considerable area in mathematical learning involves learning and adopting an effective computational process and capacity. Researchers have thus been interested in this area. Schoenfield (1994) [12] postulates that; we tend to solve mathematical problems according to our beliefs. For example, people that believe mathematics to be just a system of repeating established procedures are less likely to invent a new idea or handle a more challenging mathematical problem presented to them (Schoenfield, 1994) [12]. The foreseeable challenge in this kind of analysis is; the failure to recognize that parameters like beliefs result from other parameters in the environment. Once we consider a different model, we will later see how emotions lead to attitude; which then define our beliefs and ultimately who we are.

Goldin (2000) [5] went further to study the relation that exists between experience and mathematics. He has postulated the existence of diverse states where different feelings are experience in a sequential manner to affect cognition. Depending on experience, the states triggered could affect cognition in either a negative or in a positive way. This experience could also be the teaching environment. Since emotion affects the feelings that we experience, it can alter the way we perceive experience (experience can be considered as the emotions that have been experienced due to the environment) and even define it (experience) hence altering our cognitive capacities. The possible relationship between general success and mathematical success will become clear later on.

As may be noted by the presented arguments so far, a problem that prevails is the generality that has so far been used especially in the meaning of terms (Leder, 1992) [8]. There is therefore a need to be more specific oriented as pertains to the use of terms in order to study the area of affect psychology in a more exhaustive manner. To explain this, let us consider the vanity in vaguely defining some affect parameters that we have used. Consider a term like attitude. We have equated the meaning of this term as the capacity to either dislike or like. As I had mentioned earlier, the problem that may immediately surface is that; we have forgotten the existence of a host of other parameters that affect attitude in a direct way. Things like past experiences, one's hopeful career, gender, parental and societal expectations, goals among others affect one's mathematical attitude. It is therefore quite to analyze the psychology of affect by measuring and using parameters like attitude. For every single emotion that has been triggered in us, it reacts with a host of other emotions and factors to create a complex impact that may be difficult to predict.

In order to escape the difficulty experienced in the classification of components that affect mathematics; in a simple continuum where only two variables that are considered like attitude and mathematical performance, as well as avoid the difficulty in measuring these variables in this simple continuum, we need to use a different model. McLeod's (1992) [9] model uses a three dimensional approach. Apart from defining concepts, it maps diverse levels of stability to these concepts depending on their nature. The three basic concepts that have been used in this model include: emotion, attitude and beliefs. While emotion is considered to be most strong, most affective and one that is least stable, Beliefs is considered to have most effect on cognition, most stable and weakest in intensity. Attitudes on the other hand are somewhere in the middle. In social psychology however, a different approach is used where attitude has been broken down to emotion, behavior and beliefs. Both of these models are used in the evaluation of affect's role in learning mathematics, hence the need to adopt a possible common approach. Nevertheless, these models can help us picture the relationship between mathematics and emotion.

It is quite difficult to establish the relationship between mathematics and emotion without considering the motivational aspect. One reason for this is the embedment of mathematics in nearly all areas of our lives. The result is that at one point or another, we have been faced with the task of exploiting all our energy to learn mathematics. In this endeavor, we have sough internal as well as external motivation to grasp mathematics. Mathematics has been inescapable particularly because; we almost all need to orient to it in order to achieve our goals. As we had seen, our system has a way of prioritizing and organizing corrective plans intended to rectify a prevailing circumstance as we seek to achieve our goals. However, considering that learning mathematics may not really be one of those most urgent priorities; and may still face disturbance from other needs that will arise, the process of self-regulation would be of more importance in mathematical motivation. This would be elaborated shortly.

Motivation-Emotion-Cognition relationship

Two approaches have torn researchers as they have strived to psychologically analyze man. There is the social approach on one hand that considers the aspect of; non personal mathematical experiences, emphasizing on shared experiences (Hannula, 2000) [6]. This is a logical approach taking into account that mathematical knowledge has been built over many generations that have shared their experiences. On the other hand, we also need to consider how individuals think by themselves in relation to mathematics. An approach that can therefore be of aid to us will involve integrating the following areas: Cognitive, emotion, motivation (Hannula, 2000) [6]. By considering self-regulation, I believe that it is possible to integrate the following areas as well as merge the social and the personal aspects of learning mathematics; at least to some extent.

In order to understand how these areas interact, observing man as a system that has self-regulating capabilities would therefore be an appropriate approach. According to Zimmerman & Campillo (2003) [14], self-regulation can be described as the process of acquiring a thinking pattern, adopting some feelings, and a behavior in order achieve intended goals. Boekaerts (1999) [1] has proposed a three concept kind of model in the study of self-regulation: an innermost layer that considers taken cognitive styles which

in turn determine control of the kind of processing style, a middle layer that considers the use of skills, cognition loops, as well as knowledge to control learning, an outermost layer that concerns with the application of chosen goals and available resources to control the individual.

Our self-regulation abilities capture the importance of motivation in learning. Although the layers that have been described above can be viewed in isolation, it is more important to try and picture the relationship among them. The third layers for example illustrate the importance of resources which act to motivate an individual. This may in turn enable an individual acquire appropriate skills and knowledge to control the learning process. We are almost all coerced to adopt motivation while learning mathematics either on our own or by the help of others. The belief is that by adopting some behaviors and beliefs that align with mathematical learning, we can achieve success in mathematics. Hannula describes motivation as a characteristic that gives birth to actions that manipulate our emotions.

This can be seen for example during the process of solving a mathematical problem when motivation is involved. This may lead to believing that it is important to solve this problem hence worth the effort; an aspect of cognition. Moreover, it may lead to the application of persistence; an aspect of behavior. On the other hand, emotions come out openly; as we express joy at successfully solving the problem or sadness and even anger when we fail to achieve the goal of successfully calculating the mathematical solution (Hannula, 2000) [6]. This may in turn have a more profound effect on us; as when our self-image is defined. We may for example view ourselves confidently; as pertains to our capacity to solve mathematics. Relating this to our earlier discussion; on the relationship between our ego and success, we can understand the permanent impact that a single mathematical experience may have in us. Moreover, this may determine our future mathematical experiences setting off a chain reaction that will permanently ingrain in us our self-image, shape our attitudes and determine our success in the long run. This can be used to explain the observable relation between mathematical success and general success.

Let us briefly go back to the to the McLeod's model of emotion, attitude and belief; three dimensional that I had mentioned earlier. Emotions were described as being unstable, spontaneous as well as being most affective. Although they are spontaneous, they define our experience, hence will lead to the development of attitudes that are more stable, and ultimately to the development of beliefs which had been descried as; having the most effect on cognition, being more stable and least spontaneous. Our character in general is therefore determined by our beliefs. Indeed, the fact the beliefs are less spontaneous means that most of our unconscious and impulsive actions are driven by our beliefs. Motivation is therefore capable of stimulating either positive or negative emotions leading to attitudes and ultimately to beliefs that in the end define our general behavior and character that determines majority of our actions in the end.

Conclusion

For the purpose of this paper, we need to view motivation as any action or components in our external or even our internal environment that can inspire any type of emotion in us. We also need to view motivation as a stimulant; which, when it combines with other factors, it leads to other sequence of motivations. The tone of the instructor in a classroom setting may motivate a student to be attentive and interested or inhibit the same. Appropriate emotions may be inspired in this particular instance; depending on how the student has interpreted the tone. When the student has been inspired to learn mathematics, depending on other factors, he may experience other emotions in turn; this may occur in a situation when he gets the correct answer in a mathematical problem, or when he fails to find the right solution. This may as a result motivate a different or a similar attitude from the previous experience. He may for example feel joy at as a consequence of correctly tackling the mathematical problem, or feel anger at failing to do so. We cannot therefore view a single motivation in isolation. We have to consider the complex relationship shapes one's emotions, attitudes and beliefs leading to the development of a character. This character determines in turn how we may be successful in mathematics.

Having talked about self-regulation, we have seen that it is possible for our systems to be motivated by some parameters in our environment; to control ourselves in a way that will achieve our goals. In this process, one thing we are trying to do is to stop the way we automatically react to some emotions. We want to control how we react to some emotions. For example, a self-regulating student may be inspired to love mathematics even after failing to correctly solve a mathematical problem. In order to do this, we apply the use of cognition to get a picture of our experiences. We are also able to understand another way in which cognitive is related to emotion by understanding the capacity of our emotions to direct our cognitive sequences and capacities. An emotion of fear for example is capable of ordering our attentiveness towards discouraging type of information. Our capacity to concentrate is also birthed in part by our prevailing emotional conditions. As we had seen earlier, our capacity to remember particular details as well as events is a direct product of our concentration and attentiveness. This in turn defines our cognition capacity.

The relationship that has been explored therefore in conclusion illustrates a relationship between the following parameters in particular: Cognition, motivation and emotion. These aspects are hardly missed in any learning environment. It comes at play in the classroom, when solving a mathematical problem or when trying to understand a mathematical process among other possible events. Emotion plays a very critical state in this relationship that we have described. All learning experiences are composed of emotional components that inter relate with motivation and cognition among other factors. This emphasizes the importance of emotion in the process of mathematical learning and development.

Need for further research

I began by considering a general theory of learning; linking our emotion to general earning. We have seen that man can be analyzed as a system that has several characteristics enabling it, not only to achieve its goals, but also to prioritize its goals and monitor the progress in achieving these goals. Emotion therefore has evolved as an important component driven to an extent by the monitoring mechanism. This approach was helpful, particularly because we need to understand how learning in general occurs. As we learned later, a link to general success and mathematical

success has been observed. Moreover, mathematics has embedded many areas of our lives that it is almost impossible to view it in isolation. In the process, we established the important relationship between memory and emotion. Moving on, we observed methods, approaches and models that have been employed to study the role of emotion in learning. The ability to self-regulate ourselves emphasized the role of motivation in mathematical learning, which has a relationship with its cognitive and emotional sisters. In order to understand the role of emotion and mathematical learning in a better way, there is a need to appropriately merge the vast array of research in this field in a knowledgeable way, integrate psychology and scientific tools in the study, and implement an exhaustive research to develop satisfactory theories.

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