

Comparison of the Influences of Different Types of Extrinsic Motivation on Different Age Groups of Learners' Math Anxiety Level

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Abstract. Motivations, including intrinsic and extrinsic motivations, are impactful factors that contribute to the development of math anxiety or increasing math anxiety level of learners at different ages. Considering the importance of mathematics for the population in the society today and the fact that math learning is not enjoyable for everyone, reviewing and comparing the effects of different types of extrinsic motivation on varied age groups of learners' math anxiety level is necessary. Specifically, the present paper compared the influences of external regulation, introjected regulation, and identification on elementary age learners' math anxiety level and adolescent learners' math anxiety level, and found three major differences among the influences of the three types of extrinsic motivations between the two age groups: first, external regulation from authority figures has more negative effects in math anxiety of elementary age learners; second, external regulation from peers and society are more influential factors causing the alteration of the adolescent learners' math anxiety level; third, identification-led math anxiety aggravates as pressure of math learning increases. It aims to provide assistance to the teachers and caregivers of the learners on promoting the learners to make use of their full potential in math learning, and also, aims to provide reference for future studies in relevant fields. It is expected that future studies would conduct relevant researches more creatively and look into specific areas in the field (for example, identification in different levels of learners and introjected regulation in learners) in order to dig deeper into the field.

1 Introduction

Topics associated with math learning is always debated upon, mostly regarding the value of math in education of an individual, and the causes of poor understanding of math and poor math performance among populations around the globe. It seems that not only a few, but a large population in a wide-ranging age are experiencing negative emotions while facing numbers and math problems whether in real-life situations or in academic contexts, that is, math anxiety [1]. In this case, progressions in math learning in academic situations of the population is likely to be motivated extrinsically, which means that math learning is considered a tool for the individual to reach the desired outcome, such as getting the entrance requirements to a major, instead of a source of joy.

By reviewing the previous studies in the relevant fields, it could be found that few studies linked math anxiety and the four specific types of extrinsic motivation together for investigation. Considering the importance of the role mathematics plays in different fields and the strong impact of math anxiety on math performance, the need for further reviewing and analysing the relationship between math anxiety and extrinsic motivations in varied age groups from previous

studies is indeed significant. Therefore, the present paper will explain relevant details of theories regarding math anxiety, extrinsic motivation, and psychological features of the elementary age learners and adolescent learners, and then discuss and compare the influences of different types of extrinsic motivation that often exists in daily and academic situations on their math anxiety levels to assist the teachers and caregivers of math learners in choosing the most suitable way to promote the the learners to make use of their full potential, and provide further studies in the fields with relevant information.

2 Extrinsic motivation

2.1 Learning motivation, intrinsic and extrinsic motivation

Learning motivation is the drive for one to do something. It can be roughly classified into two basic types as suggested by Deci and Ryan: intrinsic motivation, which refers to a person's spontaneous motivation which is not triggered by the outside factors but out of one's free will to experience the event, and extrinsic motivation, which is the motivation generated due to external influences and aiming for a valued outcome, such as completing an

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experimental task for the promised payment, or working hard for avoiding the punishment for failing the test (i.e., the behaviour is instrumental) [2].

2.2 The four types of extrinsic motivation

Self-Determination Theory (SDT) is a motivational theory taking the humanistic perspective in psychology and proposing three basic psychological needs of each individual: competence, autonomy, and relatedness [2, 3]. It stated that only satisfaction of these three needs would allow autonomous motivations to act in place, and when the satisfactions are not fulfilled, negative emotions arise.

Ryan and Deci also introduced a SDT model based on their prior investigation into the mini-theory of SDT—Organismic Integration Theory (OIT), indicating that external motivations vary according to the degree of autonomy of the motivation [3]. Four types of extrinsic motivation are distinguished in their model: external regulation, introjected regulation, identification, and integration [3].

External regulation is the most commonly recognized and studied motivation in the field. This type of motivation is the least autonomous, and the individual's behaviours are to be influenced, or more precisely, controlled by external influences, which, with reference to Skinner's operant conditioning theory, is positively reinforced using rewards to increase the frequency the behaviour occurs, or positively punished using punishments to reduce the frequency of the behaviour [3, 4].

Introjected regulation is a relatively less controlled type of extrinsic motivation. Individuals encountering introjected regulations are spontaneously pressurized by their will to avoid undesirable internal emotional consequences (anxiety, guilt, stress, etc.) or obtain their desired internal rewards (self-worth, self-esteem, etc., arising from completing the task or achieving a goal) [3].

In contrast to external regulation and introjected regulation, identification and integration are more self-determined extrinsic motivation. In identification, the external orders are accepted by the individual as the individual recognizes the value of the behaviour [3]. Integration is the point in which the value of one behaviour is internalized in the individual that the individual regulates himself/herself toward doing the work autonomously [3]. This type of external motivation is very similar to intrinsic motivation in many ways, yet since the behaviour is still instrumental, it is still considered as an extrinsic motivation [3].

These four types of extrinsic motivation interfere with each other to move the individual toward accomplishing their goals, and how they motivate one to progress shows significant influences to an individual's attitudes to academic tasks and hence, their academic performance and achievements.

3 Math anxiety

3.1 Math anxiety and symptoms

Anxiety is defined as the fear and helplessness that come with the sense of being in danger [1]. Deriving from that was test anxiety, and then, math anxiety in the academic context.

Math anxiety is a specific form of academic anxiety, with the individuals experiencing stress and anxiety feelings that interfere with manipulating numbers and solving math problems in both daily life situations and academic contexts [5]. More specifically, individuals with math anxiety may experience greater difficulty to focus on the content delivered, greater fear and embarrassment of answering questions in class and making mistakes in the scenario, and they would make excessive comparisons and have excessive worries about their abilities [6]. Also, they may avoid taking elective math classes and choosing math-related careers when they are with long-term math anxiety [7].

3.2 Negative consequences of math anxiety

3.2.1 Consequences regarding working memory capacity

It is found by multiple studies previously that working memory is highly relevant to an individual's math anxiety level [8]. An individual with math anxiety may experience difficulties in controlling their anxiety emotion while facing situations that trigger their anxiety, and that may reduce the individual's working memory capacity and attention, which are already severely limited, distributed to solving the math problems since there is a need for regulating their anxiety level at the same time [9, 10]. The retrieval of basic mathematical concepts and application of mathematical skills that are key to solving math problems are to the very dependence on working memory as commonly believed; as a result, math anxiety has usually been linked to deficits in working memory capacity of this certain population.

3.2.2 Consequences from the causalities between math anxiety and weak math performance

With reference to the Interference Model of test anxiety, in the short-run, math anxiety is likely to cause negative impacts on the math grades of the individuals [7]. It drew a causal relationship between math anxiety and math performance of the learner according to the negative consequences arising from math anxiety, such as disrupting the working memory capacity. In the long-run, not only the math grades of learners would be negatively affected, but also would the learners' overall attitudes towards math learning be altered. This results from the vicious circle created by the learner's anxiety and weak math performances, referring to the Reciprocal Theory proposed by Carey et al., which addressed the possible bidirectional causality between anxiety and weak performance [11]. The severely affected individuals also tend to miss career opportunities that could bring them better economic status in the future due to their intentional avoidance of science, technology,

engineering, and mathematics (STEM) related careers as mentioned previously [7, 12].

4 Influences of the three types of extrinsic motivation on math anxiety

This section discusses the influences of the the first three different types of extrinsic motivation (external regulation, introjected regulation, identification) existing frequently in daily situations throughout the process of math learning on math anxiety of different levels of math learners based on previous literature in the field. External regulation and introjected regulation are discussed together as they are closely tied and are both more controlled types of extrinsic motivation.

Because integration is not common among young learners and exists in almost the same form as intrinsic motivation on learners, it is rarely identified and investigated on empirically in the field [13]. Especially in young children and most developing adolescents, integration can hardly be assessed for their identities are not fully developed and they are not yet matured. Thus, the present paper will not be discussing about the effects of integration on math anxiety.

4.1 Elementary age learners

4.1.1 *Developments in cognitive skills and psychological features*

Elementary age learners around 6-12 years old are not yet mature in their cognitive skills and not yet independent enough. During this stage of life, they develop a more logical way of thinking from the primary naive thinking and acquire concepts rapidly via establishing associations and classifying acquired knowledge [14]. The children also tend to be more curious and willing to explore their environment.

Meanwhile, the individuals start to develop their self-esteem and also become less egocentric to be influenced more easily by their environment in these years.

4.1.2 *Controlled regulations—external regulations and introjected regulations*

Commonly used external regulations for elementary age learners are extrinsic rewards. It could be a promised gift or oral appraisals from the caregivers for certain achievements of the child, or possibly, peers' acceptance. This type of extrinsic motivation works especially well for improving elementary age children's academic performance as it increases the sense of achievement attained from the accomplishment, yet only is this true when applying it to short-term learning [15]. In the long-run, frequent use of extrinsic rewards reduces intrinsic motivation, more specifically, the children's innately high level of curiosity and will to explore [16]. According to a number of previous studies, the effect of intrinsic motivation on learners are more powerful for the learners to reach master levels of understanding of

knowledge and continuously progress throughout their learning process with a positive attitude [17]. The disturbances from extrinsic rewards would diminish this intrinsic motivation until a point that without rewards, the learners lose interests for learning. At this time, while learning, the learners are less likely to concentrate fully on the tasks and fall into a negative mood, such as impatience and frustration, with greater ease even if the reward is present to try to motivate them accordingly to the SDT that the basic psychological need of competence and relatedness are not satisfied. Math anxiety is likely to be generated and aggravated in this case while the individual progresses in mathematics in accordance with the Reciprocal Theory proposed by Carey et al., especially when oral appraisals or admiration from caregivers or peers are the rewards, for direct interactions with caregivers and peers means much more than physical rewards—they could represent love from caregivers and the status of the individual in the small community [11]. One worth noting point here is that the extrinsic rewards had now transformed into extrinsic punishments and also introjected regulations of pressuring the self.

Introjected regulations generated in the elementary age learners are of greater influences in the learner's math anxiety than that of introjected regulations generated in adolescence stage in the long-term perspective, considering the build-up of math anxiety in a learner with age increase [18].

4.1.3 *Identification*

Identification is the most self-regulated type of extrinsic motivation amongst the three types analyzed. According to the empirical study conducted by Sungur and Senler, it is the extrinsic motivation that is of significantly high level of motivation in comparison to other types of extrinsic motivation for the elementary age learners, indicating that the higher the relevance of the activity is to the learner, the higher level of motivation there is for the learner [17].

This type of motivation is less likely to cause negative emotions and anxiety in the learning process, more likely to result in better performances, more persistent learning of learners, for the learners do understand that the behaviour is to be done in order to receive the desired outcome [19]. For example, an elementary learner is likely to be more willing to learn a foreign language if he/she recognize the fact that being able to travel around the globe requires proficient language skills. In math learning, identification also acts as a strong and positive motivator for the learner.

Nonetheless, on the other side, this type of motivation may also cause increased level of negative emotions and anxiety in some young learners. These learners usually find math important, yet have a low confidence in math or have poor math skills. If a learner is motivated by identification, it means that the learner had found the importance of behaviour. here, learning math. In this case, he/she may strive to learn math to reach the goal, and in this process, if the math

performance of the learner is weaker than expected, the learner may experience greater pressure because he/she could not afford failing to reach the goal. The greater pressure is likely to lead to anxiety when doing math, especially during math assessments when timing is present, and worsen the math performance for a greater proportion of the limited capacity of working memories are used for being anxious but not for solving math problem, leading them into the vicious circle of the Reciprocal Theory unless they are able to make effective adjustments to jump out of the vicious circle [10, 11].

However, identification is not very common among young elementary age learners but older elementary age learners, adolescent learners, and adult learners because a certain cognitive level and maturity has to be met before they are able to realize the importance of a behaviour.

4.2 Adolescent learners

4.2.1 *Developments in cognitive skills and psychological features*

Individuals usually would have developed their cognitive ability and working memory capacity in adolescence stage of their life to the similar level as adults [14]. They are able to think logically and reason using their attained knowledge at this stage, and this helps them to make use of multiple executive processes in different scenarios and progress into next levels in both their personal life and academic life.

Regarding the social and emotional developments, adolescents reach the point of questioning their identity, and more undesirable emotions appear inside the individuals during this process. One of the causes of these unpleasant emotions in the process is peer influences, which are of a greater weight for the individuals than before. Another influential cause may be conflicts between their ideas to their family members' due to generation gaps occurring with the progressing society.

4.2.2 *Controlled regulations —external regulation and introjected regulation*

External regulations from caregivers or teachers are likely to be of less effect on improving adolescents' math performance for adolescents in comparison to that of the elementary age children due to the interactions of the regulations with their increased need of autonomy and reduced engagements in learning [20]. Direct results of external regulations of caregivers or teachers in the math learning process may be reduction of the motivation of the adolescent learners while diminishing the need of autonomy, which would then lead to negative emotions that links to the math-related activities. And more specifically, in the classrooms, the teachers' extrinsic punishments such as completely denying the wrong answers given by the learners instead of arguing and guiding the learners through the process the problem is solved may also reduce the motivation of the learners

and add on to the math anxiety of the students due to the unsatisfactory need of autonomy, competence and relatedness [21]. This cause, similarly, results in rise in math anxiety level of of the elementary age learners.

The external regulations from peers are likely to have a greater influence on adolescents' math anxiety level, both directly or indirectly, for their increased need of autonomy and relatedness. In the aforementioned scenario when the learner's answer is denied in class, the learner's need of relatedness is not fulfilled for the classmates are present to watch him/her making the mistake. Not only at this point is the learner's math anxiety level directly influenced and increased, but also at the point, introjected regulations arise to further affect the learner. These introjected regulations include the willingness of avoiding anxiety and fear, and reduction in self-esteem and self-worth from the imagined loss of acceptance from peers. As suggested by Lim and Chapman and with reference to the Reciprocal Theory proposed by Carey et al., less self-determined motivations are less likely to lead to improved math performance due to the interferences of the pressure put on themselves when doing math and the likely worsened performances [11, 22].

In addition, external regulations from the society (for example, stereotypes on girls' math performance and suggestive comments of social media that are relevant to the learner's experience) play a more significant role in motivating the adolescent learners toward progressing in math learning and generating introjected motivations in themselves, mainly due to their increased need of autonomy and relatedness. Math anxiety level may be reduced or worsened depending on the personality of the adolescent and the content of the external regulation. According to a number of studies, stereotypes that says "girls are not as good at math and science than boys" do have strong influences on the female learners from a young age to adulthood—it is often reported that girls admit higher levels of math anxiety than boys [18]. The likely and relevant explanation for this result suggested is that many girls are afraid of confirming this stereotype and so are motivated by introjected regulation generated in themselves to thrive for better math performance, which includes emergence of negative emotions during the process of math learning and assessments.

4.2.3 *Identification*

As mentioned previously, identification is more common in adolescents than that of young elementary age children, and the influences of it is similar to that of elementary age children. But it is likely that the level of math anxiety is not as severe or as mild as that of the young learners, for the adolescents are more capable of regulating their emotions with increased level of maturity or they may face higher level of pressures and introjected regulations from higher levels and greater number of tasks with greater importance to complete.

5 Conclusion

The present paper reviewed and compared the three identified types of extrinsic motivations in the SDT model (external regulation, introjected regulation, and identification) in different age groups based on previous literatures in the fields. It is found that external regulations from authorities for the elementary age learners are more influential for improving the math performance of them but meanwhile, increasing their math anxiety level through extrinsic punishments and the generated introjected regulation; external regulations from the society and peers is more influential in comparison to external regulations from authority figures on the adolescent learners considering the special psychological features of adolescents (greater needs of autonomy and relatedness, increased independence and level of cognitive skills); and identification-led math anxiety aggravate as the pressure of completing the tasks increases. It could provide assistance to the teachers and caregivers of the learners for reducing the math anxiety level of the learners and promoting them to make use of their full potential in math learning; also, provide reference for future studies in relevant fields.

Aside from that, through reviewing, it can be seen that a number of the previous studies did not consider cultural influences and the specific personalities on the responses generated by the learners to the types of extrinsic motivations and math anxiety level; hence the population generalizability of the studies is limited possibly due to scarce resources available for conducting these empirical studies. In future studies, avoiding homogeneity and promoting creatively in identifying and investigating in more specific issues (such as carrying out the research in multiple countries or regions and selecting specific types of participants to participate the research) is an inevitable part of digging deeper into this field.

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