

# Application of Vygotsky Theory in High School Mathematics Learning Material Limit Functions

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## Abstrak:

Matematika merupakan mata pelajaran yang ada pada semua jenjang studi dan memerlukan kemampuan berpikir logis, mengorganisasikan, dan mendemonstrasikan. Salah satu materi yang membutuhkan kemampuan tersebut dalam matematika adalah materi fungsi limit. Materi fungsional batas menjadi dasar penguasaan materi selanjutnya yaitu materi turunan. Fakta bahwa siswa tidak memiliki pemahaman yang kuat tentang literatur fungsi limit menunjukkan bahwa siswa tidak berhasil secara akademis pada tingkat ini. Hal ini dikarenakan siswa mengalami kesulitan dan melakukan kesalahan dalam memahami konsep, fakta, dan prosedur dalam literatur fungsi limit. Teori Vygotsky dapat diterapkan pada materi fungsi limit. Vygotsky menerapkan Zone of Proximal Development (ZPD) yang merupakan tingkat perkembangan sedikit di atas tingkat perkembangan seseorang saat ini. Ketika anak-anak mengalami kesulitan belajar, Vygotsky menyarankan agar guru dapat menggunakan scaffolding sebagai dukungan atau bantuan melalui seseorang yang lebih mahir dalam menguasai materi untuk membantu pemecahan masalah, masalah bagi orang-orang dengan tingkat perkembangan kognitif yang lebih tinggi.

**Kata Kunci** : matematika; limit fungsi; teori vygotsky; ZPD scaffolding.

## Abstract:

Mathematics is a subject that exists at all levels of study and requires the ability to think logically, organize, and demonstrate. One of the materials that require this ability in mathematics is the limit function material. The boundary functional material becomes the basis for mastering the next material, namely derived material. The fact that students do not have a solid understanding of the limit function literature indicates that students do not do well academically at this level. This is because students have difficulty and make mistakes in understanding concepts, facts, and procedures in the limit function literature. Vygotsky's theory can be applied to the matter of limit functions. Vygotsky applies the Zone of Proximal Development (ZPD) which is a level of development slightly above a person's current level of development. When children have learning difficulties, Vygotsky suggests that teachers can use scaffolding as support or assistance through someone who is more proficient in mastering the material to help solve problems, problems for people with higher levels of cognitive development.

**Keywords** : mathematics; limit function; Vygotsky theory; ZPD scaffolding.

## Introduction

In the development of science which increasingly demands an increase in the quality and quality of students, one of the most important subjects is mathematics (Rahmah, 2018). Mathematics is a subject that exists at every level of education starting from elementary school (SD), middle school to university (PT) which in its application requires the ability to think patterns, organize patterns, logically prove (Cholily et al., 2019; Murnie, 2020; Nugraha et al., 2019). In defining language representation, mathematics uses symbols

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carefully, clearly, accurately and densely so that mathematics has distinctive characteristics, namely systematic, abstract, and the methods used in deductive learning (Azizah & Jayanti Putri Purwaningrum, 2019; Ekawati, 2017; Sutiarmo, 2017).

The deductive method is an analytical method or reasoning process, a thought process to draw or draw conclusions about a particular problem wisely and logically that has been proven by assuming the truth (Azizah & Jayanti Putri Purwaningrum, 2019; Fitriani et al., 2021; M. A. Rahmah, 2018; Widiyaningsih, 2012). A theory can be admitted deductively if a researcher can prove a new theory, for example the formulas contained in the limit function material (Norkhamid, 2017; Pratiwi & Zuliarni, 2020).

Based on the results of the survey in the field, the function limit material is a science that is difficult for students to understand because it requires a high level of accuracy and creativity when completing it (Yusdiana & Hidayat, 2018). Norkhamid (2017), states that limits always appear in school exam questions, and also includes basic material that must be mastered in order to be able to master further material such as derivative material. Without realizing it, in everyday life we also encounter limit material so that the essential limit material is not only for mathematics but can be used in other subjects. The fact that students' problem-solving abilities about function limits are still weak, it can be seen that at this level students have not succeeded in learning the limits of functions (Darmayanti & Sugianto, 2022; Noto et al., 2018).

There are several types of difficulties in studying limit function material in terms of the type of error and the type of difficulty. In research (Dewi et al., 2020; Salido et al., 2014; Yusdiana & Hidayat, 2018) clearly stated: Errors made by students when solving problems about the limit of a function seen from mathematical objects include (1) conceptual errors, namely students making mistakes when drawing conclusions about the limit value of a function, students making mistakes in determining the method or steps to solve the limit of a function. functions, for example in questions of primitive forms, this is because students do not understand the limit properties of trigonometric functions, (2) the main error is that students do not understand. the concept of determining the area of the proportional function area, students do not understand the concept of exponents and students misinterpret the rules that apply to mathematical operations, (3) procedural errors, namely students incorrectly answer the procedure, students misunderstand being tricked through the screen and students are wrong in the substitution process. This failure was caused by students having difficulty in understanding the concepts, facts, and principles of the limit function material. The relatively low ability of students in the limit function material can be caused by several factors (Dewi et al., 2020; Junaedi et al., 2015).

Factors that cause students to make mistakes in solving function limit questions are as follows: (a) students do not fully understand the material related to the definition of limit functions to completion, (b) students have not mastered any properties that apply in relating the material limit functions to its application. on the questions, (c) students do not master the prerequisite concepts as the basis for studying function material and material related to function limits, and (d) students more often use the fast method and even choose to shorten the completion process so that they are wrong in writing and even substitution also factor (Dewi et al., 2020; Salido et al., 2014).

In addition, the factors that influence academic success that limit the functioning of students are the teacher's teaching methods, facilities and infrastructure that support the student's environment to create a beneficial environment. The boundary function in learning should focus more on finding and using ideas and relationships between concepts (Fuady et al., 2017; Imamuddin et al., 2020; Novita et al., 2018).

Learning the limits of this function, students need mathematical reasoning skills to perform calculations based on applicable formulas or rules and can estimate, then draw

conclusions based on concepts. Mathematical concepts and insights cause differences in one's thinking about solving boundary function problems because each person's individual observations are different (Yusdiana & Hidayat, 2018; Gan et al., 2021).

With this in mind, understanding the functional limits of matter requires several people to compare thoughts or views in the problem solving process related to functional boundaries and someone who is more competent to be able to guide one's analysis to adapt existing concepts (Darmayanti et al., 2022). Students must be able to find solutions to a problem not only from one point of view, but also from many other points of view, so as to arouse students' thoughts so that they are not only monotonous in their state of mind. It is important for children to come up with different problems to solve the problem (Azizah & Jayanti Putri Purwaningrum, 2019; Hidayati & Widodo, 2015). This must also be supported by the presence of an expert who leads and ensures that the thinking used in problem solving is correct.

One of the teachings that are oriented in this regard is that Vygotsky's theory applies the area of proximal development which is a level of development that is slightly higher than a person's current level of development (Basri & Selatan, 2013). So, in theory, Vygotsky suggested that teachers could take the scaffolding and apply it to continuous learning or need adult support or more competent to help children deal with problems at their level of cognitive development (Abi, 2020; Chairani, 2015a; Ivars et al., 2020; Sa'adah et al., 2021). With this form of theory teaching, it can have an impact on increasing children's cognitive development in learning (Wardi et al., 2021)

Research conducted by (Azizah & Jayanti Putri Purwaningrum, 2019) states that by applying Vygotsky's theory in mathematics subjects, namely geometry material, it will make it easier for students to understand geometric material that is considered difficult. Based on the background and the results of previous studies, the researchers tried Vygotsky's theory with other materials, namely the function limit material. The facts in the field that are currently happening that demand 21st century education in accordance with the development of science and technology that coexist with education, this research needs to be investigated in different subject environments in line with curriculum development. The results of this study will determine the steps in further research (Meilani et al., 2020; Nahdi, 2019; Syahlan, 2015).

## **Method**

This research method uses a deductive method. The deductive method is an analytical method or reasoning process, a thought process to draw or draw conclusions about a particular problem wisely and logically that has been proven by assuming the truth (Azizah & Jayanti Putri Purwaningrum, 2019; Fitriani et al., 2021; M. A. Rahmah, 2018; Widiyaningsih, 2012). A theory can be admitted deductively if a researcher can prove a new theory, for example the formulas contained in the limit function material (Norkhamid, 2017; Pratiwi & Zuliarni, 2020).

## **Result and Discussion**

### **Vygotsky's theory**

Lev Semenovich Vygotsky is a professional figure in literature, psychology and philosophy from Russia (PeranginAngin et al., 2021; Shabani et al., 2010). Vygotsky was a universalist who believed that the logic, principles, and rationality of scientific thought apply to every individual in society (Anidar, 2017; Danoebroto, 2015). Vygotsky's most famous philosophy concerns the environment and people. Vygotsky argued that humans

differ from animals only in reacting to the environment, while humans can modify their environment according to their abilities and according to their needs (Lasmawan & Budiarta, 2020; Suci, 2018a). This is the seed of the emergence of social constructivism which represents the cognitive formation of children after social interaction (Mahmudah, 2020). Vygotsky's thinking is a sociocultural perspective that discusses the influence of cognitive construction on the nature of activities in the sociocultural environment (Cahyono, 2010a; Verrawati & Mustadi, 2019). The basis of this theory is that what students learn today in groups can also be done alone in the future. Vygotsky argues that students have different levels of development, which are divided into two, namely potential development and actual development (Chairani, 2015a; Suardipa, 2020; Supiarmo et al., 2021). The actual level of development is the level of development that occurs in students when they are able to independently use their cognitive abilities functionally. While the level of cognitive development that can be achieved by a student with the help of a more competent or adult person is known as the level of potential development (Pasaribu, 2013; Rohaendi & Laelasari, 2020). Based on this, Vygotsky recommends that a teacher can develop discussion skills with students or students can collaborate with colleagues by asking questions about the material (Nahdi, 2019).

According to Vygotsky, in the early stages of cognitive development, students must go through low-level mental processes (Anidar, 2017; Suci, 2018b). Then move on to higher mental processes. This can be achieved by having competent partners (Anisah, 2010; Yousif et al., 2018). Furthermore, students also need challenging tasks, for example questions with higher-order thinking skills to help improve their cognitive development (Santoso et al., 2021; Supiarmo et al., 2021). With this, students acquire cognitive tools in the form of visual symbols, as well as problem solving. When a student carries out social activities that benefit students, this event is called internalization (Bagchi & Wells, 1998; Pamungkas & Siswanto, 2021; Rehalat, 2016; Wardi et al., 2021).

To bridge the internalization process, Vygotsky relied on the area that lies between potential development and actual development, called the Zone Of Proximal Development (ZPD) (Shabani et al., 2010; Silalahi, 2019; Suardipa, 2020). In addition, ZPD also means learning that can be reached by students. The stagnation of students' cognitive abilities is caused by the actual zone which is too easy. So expert assistance or someone who is competent is needed so that this does not happen either from the teacher or from the parents of the students themselves (Marinda, 2020; Naufal, 2021). ZPD contains development and learning (Akhiruddin et al., 2019; Cahyono, 2010b).

Learning must be directed at developing the potential that exists in students and not on actual development or learning that has been mastered by students (Sari et al., 2017). One of the important characteristics of learning is learning to generate internal development processes in children that develop when children interact with the environment and work together with friends (Silalahi, 2019). Tharp and Gallimore (Cahyono, 2010a; Yohanes, 2021) suggested that the level of development of the ZPD consists of four stages, namely: (a) *More Dependence on Other Stage*, at this stage the student's performance gets a lot of help from other people. parties such as peers, teachers, parents, community and experts in their fields; (b) *Less Dependency External Assistance Stage*, at this stage student performance gets a lot of help from other parties such as peers, teachers, parents, community and experts in their fields; (c) *Internalization and Automation Stage*, at this stage student performance is more internalized automatically. Awareness of the importance of self-development can emerge by itself without greater direction and coercion from other parties. At this stage the child has not yet reached maturity, which is actually still looking for identity or identity in an effort to achieve mature self-capacity; (d) *Deautomatization stage*, at this stage students have been able

to express or eliminate feelings from the heart, soul and emotions that occur repeatedly. Outages occur when peak apparent performance occurs at these four points.

Vygotsky has a level of understanding knowledge or more to speak, multi-level knowledge known as scaffolding is intended to support students in the learning process and then give students the ability to take responsibility when the teacher reduces assistance so as to provide an excellent opportunity for students to work alone (Chairani, 2015). Guidance, encouragement or enthusiasm, as well as warnings and problem solving are forms of support that teachers can provide to students so that students are more independent (Dintarini, 2021; Raya et al., 2018). There are three types of achievement proposed by Vygotsky as a problem-solving effort, namely: (a) students can perform well; (b) students can achieve success with help; (c) The student failed.

From the explanation above, it can be concluded that scaffolding is a teacher's or teacher's effort to support students to lead them to success. The encouragement of a teacher is the most important contribution for students, because with this encouragement the success of students in further studies becomes optimal (Sunaryo & Fatimah, 2019).

### **Application of Vygotsky's Theory in Mathematics Learning Material Limit Functions**

Mathematics is a science that is important for the development of human thinking capacity and is also important for many other sciences. To overcome the learning needs of the 21st century, students must be able to think logically, systematically, creatively, critically, and master concepts from an early age (Nahdi, 2019). The significance of Vygotsky's theory (Madaniyah et al., 2021) in learning mathematics is divided into two groups, namely: (a) Preparing cooperative learning (cooperative learning) between groups of students with different levels of ability. The zone of proximal developmental functional limits can be increased through one-on-one tutoring by more qualified peers. Learning like this makes it easier for students to find and understand difficult concepts (such as ratio functions, concepts of left and right limits, limit functions, and limits of trigonometric functions) because they teach the same thing, and also discuss similar problems. so that they can learn to think properly; (b) A learning approach that focuses on scaffolding will have a great responsibility in student learning. Suppose a teacher leads several groups of students to ask questions, for example about the concept of a limit function in the form of a square root, then transfers responsibility for discussion to students in their respective groups.

### **Conclusion**

With the application of Vygotsky's theory in the literature on limit functions, students will easily understand the material on limit functions that are considered difficult. In addition, it can also indirectly improve the cognitive development of students. It is hoped that the results of this study can be used as a solution to overcome difficulties in the learning process, especially in mathematics and other subjects. In future research, it is hoped that the application of Vygotsky's theory in learning mathematics can improve students' emotional and psychological development. further assess students' mathematical abilities in the boundary function literature by applying the appropriate model or approach.

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