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Variableistic Analysis of Number Conversion Mathematical Problems

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Abstract

This study aims to explore the understanding of students in the Computer and Network Engineering (TKJ) specialization at vocational high schools (SMK) in solving mathematics tests focused on number conversion. The primary objectives are to identify and analyze the errors made by students in converting decimal, binary, octal, and hexadecimal numbers, evaluate their perceptions of the test, and assess their mathematical communication skills. This research employs a mixed-method approach, using quantitative methods to analyze the validity and reliability of the number conversion test instruments, and qualitative methods to delve into students' understanding through content and thematic analysis. The study population consists of TKJ students at SMKN 4 Pontianak, with a purposive sample of 32 tenth-grade students. The findings reveal several common errors, including difficulties in repeated division and digit grouping. Data indicate that 36% of students disagree that they understand decimal to octal conversion, and 18% disagree with decimal to hexadecimal conversion. Students' perceptions of test difficulty vary, with 45% feeling very confident in writing conversion steps, while 30% show significant uncertainty. Additionally, challenges in mathematical communication are evident, such as errors in representation, reading, and writing numbers. The study concludes that there is a need to improve teaching methods and evaluation to enhance students' understanding and skills in number conversion. Recommendations include developing more effective teaching strategies and providing more intensive practice to improve students' accuracy and understanding in the number conversion process.

Keywords
Content Analysis; Computer and Network Engineering; Student Understanding; Number Conversion; Mixed Method; Thematic Analysis; Mathematical Communication

I. Introduction

In the context of mathematics education at Vocational High Schools (SMK), number conversion skills are an important element that supports understanding of other vocational materials. Number conversion involves changes between number systems, such as decimal, binary, octal, and hexadecimal, which is particularly relevant in the fields of information technology, electronics, and computer science (Binary & Jme, 2010a) However, despite its importance, this material is often not taught adequately in vocational school mathematics curricula, causing students to have difficulty connecting mathematical concepts with their productive subjects.(Prakasa & Ammamiarihta, 2023)

Vocational school students have special characteristics that differentiate them from students at other levels of education. Vocational school education places more emphasis on practical skills that are relevant to the world of work (Rizky Amalia et al., 2022).

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Therefore, teaching materials developed for vocational school students must be relevant to industry needs and facilitate the development of their practical skills (Surven et al., 2022).

In an increasingly digital world, the long-term hope is that all TKJ students can easily understand and apply number conversions in various contexts, both at school and in their professional lives (Rochim, 2022). In the medium term, the target is to increase students' competence and confidence in using number conversions to solve complex problems (Gulo, 2016). Meanwhile, in the short term, teachers are expected to be able to deliver number conversion material using effective methods, so that each student can follow the lesson well and achieve optimal learning outcomes (Gerson Feoh, 2011).

However, the reality does not always match these expectations. Many class X TKJ students have difficulty understanding and mastering number conversions. Based on initial observations, most students showed a less in-depth understanding of how to convert numbers from one base to another (Sriyeni & Veronica, 2019). This situation is exacerbated by the lack of innovative and effective teaching methods that can attract students' interest in this material. Many teachers still use conventional methods that are less interactive and do not consider various student learning styles (Zulfikar et al., 2022a).

As a result, students often feel bored and unmotivated to learn more deeply. The exam results show that the average score for the number conversion material is below the expected standard (Alifiani et al., 2022). This indicates that there is a significant gap between ideal conditions and reality on the ground, which requires serious attention and appropriate solutions (Nurizlan et al., 2022).

This research is important to carry out to identify the root of the problem that causes the low understanding of class X TKJ students regarding number conversion and find effective solutions to overcome it (Charolina & Hia, 2022). By understanding the factors that influence student learning difficulties, we can design teaching strategies that are more appropriate and support increasing student competence (Mufarokha & Utami, 2022).

It is also hoped that this research can provide new insights for teachers and educators in developing more innovative and effective teaching methods. One effort that can be made is the application of more interactive and technology-based learning methods, such as the use of computer simulations or educational applications that attract students' interest.(Sahputra & Pramuditya, 2022). Thus, this research does not only focus on identifying problems, but also offers concrete solutions that can be implemented to achieve the expected ideal conditions.

This research is novel compared to previous research in several key aspects. First, the focus of this research is on class X TKJ students, which is a group with specific needs in understanding number conversions that are relevant to the curriculum and practical applications in the field of computer technology (Rochim, 2022). Second, this research does not only passively evaluate students' understanding, but also actively seeks and tests innovative teaching methods that can improve their skills (Surven et al., 2022).

Most previous research may only focus on analyzing student difficulties without offering practical solutions that can be directly implemented (Faiziyah & Priyambodho, 2022). Thus, it is hoped that the results of this research can make a significant contribution to improving the quality of mathematics education in the field of computer network engineering, as well as offering a new approach that can be adopted by other schools.

II. Research Methods

This research uses a mixed method approach, combining a quantitative approach to analyze the validity and reliability of test instruments, as well as a qualitative approach to describe student understanding through Content Analysis and Thematic Analysis. Content Analysis identifies patterns, themes, and categories in student responses, while Thematic Analysis explores student experiences, perceptions, and beliefs.

This research involved all students majoring in TKJ at SMK Negeri 4 Pontianak, with a focus on 32 class X students selected through purposive sampling. The quantitative approach ensures the validity and reliability of the test instrument, with validity measured through the correlation coefficient of item scores and total scores, and reliability assessed through analysis of variance.

Data collection techniques include giving number conversion math questions, distributing questionnaires, and in-depth interviews. Data collection tools include test questions, answer sheets, questionnaires, and interview guides. The results of qualitative analysis from Content Analysis and Thematic Analysis are expected to help design more effective learning strategies and provide insight into students' understanding of the concept of number conversion.

III. Result and Discussion

3.1 Application of Number Conversion Mathematics Test

On May 3 2024, a number conversion test was carried out at SMKN 4 Pontianak involving 32 class After the test is completed, the answer sheets are collected for further analysis. This closely supervised test aims to measure students' abilities in number system conversions, as well as providing valid and reliable data for research. The results will be used to develop more effective learning methods.

Figure 1. *Documentation of the Implementation of the Number Conversion Mathematics TEST*

After the time is up, the number conversion test answer sheets are collected for analysis. The test went smoothly and provided important data. Next, students filled out a questionnaire regarding their difficulties and understanding, and three students with different abilities were interviewed in depth. Researchers also conducted direct observations to record students' motivation and error patterns.

Data analysis involves identifying conceptual and procedural errors, as well as the influence of psychological factors such as anxiety and self-confidence on student performance. The results provide insights for improving the teaching and evaluation of number conversion in the future.

Table 1. Results of Content Analysis of Conceptual Errors and Procedures

NO	Question Paper	Error draft	Error procedure	Mathematical Communication		
				Representation	Read	Write
1.	Convert the decimal number 45 into binary form	Don't understand the basics of dividing decimal to binary	Errors in repeated division	Don't understand the basics of dividing decimal to binary.	Does not understand instructions or the concept of repeated division.	Wrongly writing the conversion results or steps.
2.	Convert the decimal number 123 into octal number form	Don't understand how to convert decimal to octal	Error in repeated division with base 8	Don't understand how to convert decimal to octal.	Mistakes in understanding repeated division with base 8.	Wrongly writing the results or conversion steps.
3.	Convert the decimal number 255 into hexadecimal number form	Incorrect conversion to hexadecimal	Errors in repeated division	Incorrect conversion to hexadecimal.	Mistakes in understanding the repeated division procedure.	Wrongly writing the results or conversion steps.
4.	Convert the binary number 101110 into decimal number form.	Misunderstanding the concept of binary to decimal	Dalah in exponential calculations	Misunderstanding the concept of binary to decimal.	Errors in exponent calculations.	Wrongly writing the conversion results or steps.
5.	Convert the binary number 1101011 into octal number form.	Incorrect grouping of binary digits	Error in binary to octal conversion	Incorrect grouping of binary digits.	Error in binary to octal conversion.	Wrongly writing the results or conversion steps.
6.	Convert the binary number 11110000 into hexadecimal number form.	Misunderstanding binary to hexadecimal	Error in creating a summary of conversion results	Misunderstanding binary to hexadecimal.	Error in creating a summary of conversion results.	Wrongly writing the results or conversion steps.
7.	Convert the octal number 57 into decimal number form.	Misunderstanding the position of the octal digits	Wrong in calculating exponents	Misunderstanding the position of the octal digits.	Errors in exponent calculations.	Wrongly writing the results or conversion steps.
8.	Convert the octal number 234 into binary form.	Doesn't understand direct conversion from octal to binary	Error in converting octal digits to binary	Doesn't understand direct conversion from octal to binary.	Error in converting octal digits to binary.	Wrongly writing the results or conversion

						steps.
9.	Convert the octal number 145 into hexadecimal number form	Error in conversion to hexadecimal	Incorrect conversion of digits from binary to hexadecimal	Error in conversion to hexadecimal.	Incorrect conversion of digits from binary to hexadecimal.	Wrongly writing the results or conversion steps.
10.	Convert the hexadecimal number 2F into decimal number form.	Incorrect calculation of hexadecimal digit values	Error in adding exponent values	Incorrect calculation of hexadecimal digit values.	Error in adding exponent values.	Wrongly writing the results or conversion steps.
11.	Convert the hexadecimal number A7 into binary form.	Wrong in calculating hexadecimal to binary	Incorrectly converting hexadecimal digits to binary	Wrong in calculating hexadecimal to binary.	Incorrectly converting hexadecimal digits to binary.	Wrongly writing the results or conversion steps.
12.	Convert the hexadecimal number 3C into octal number form	Wrong in calculating hexadecimal to octal	Incorrect conversion of decimal hex digits to binary	Wrong in calculating hexadecimal to octal.	Incorrect conversion of hexadecimal digits to binary.	Wrongly writing the results or conversion steps.
13.	Convert the decimal number 85 to binary form, then from binary to hexadecimal form.	Wrong in calculating decimal to hexadecimal	Incorrect grouping of binary digits	Wrong in calculating decimal to hexadecimal.	Incorrect grouping of binary digits.	Wrongly wrote the conversion steps and final results.
14.	Give the steps for converting the binary number 101010 into octal form, then from octal to decimal form.	Wrong in converting binary to octal form	Incorrect grouping of binary digits	Incorrect conversion of binary to octal form.	Incorrect grouping of binary digits.	Wrongly wrote the conversion steps and final results.
15.	If the octal number 372 is converted to binary, and then from binary to hexadecimal, what is the final result?	Incorrect conversion of binary to hexadecimal and calculating the final result	Incorrect grouping of binary digits And convert numbers	Incorrect conversion of binary to hexadecimal and calculating the final result.	Incorrect grouping of binary digits.	Wrongly wrote the conversion steps and final results.

The description of the content analysis of conceptual and procedural errors contained in Table 1 provides information regarding the types of errors in working on number conversion mathematical problems including conceptual errors, procedures, representation errors, reading errors and writing errors.

3.2 Thematic Analysis of Student Response Questionnaires

Analysis of qualitative data from 32 students shows that many students experience difficulties in mathematical representation when converting numbers. These difficulties include converting decimal to binary, octal, and hexadecimal, as well as grouping binary digits for conversion to octal. The main theme that emerged was challenges in mathematical communication, especially in correctly organizing and understanding conversion steps.

Table 2. Mathematical Representation Student Response Questionnaire Results

No	Question Items in the Questionnaire	Subject Response					Total respondents
		SS	S	N	T.S	STS	
1.	I understand how to represent decimal numbers in binary form.	25%	15%	17%	36%	7%	100%
2.	I can easily convert decimal numbers into octal form.	36%	16%	18%	18%	12%	100%
3.	I feel confident in converting decimal numbers to hexadecimal form	45%	14%	17%	18%	6%	100%
4.	I can group binary digits correctly when converting to octal.	40%	23%	11%	18%	8%	100%
5.	I understand how to convert octal numbers into binary form.	43%	12%	17%	18%	10%	100%

The results of the questionnaire completed by 32 students showed significant variations in their understanding and mathematical representation abilities. As many as 25% of students strongly agreed that they understood how to represent decimal numbers in binary form, while 36% of students disagreed with this statement. The ability to convert decimal numbers into octal form also shows varying results, with 36% of students strongly agreeing and 12% strongly disagreeing. Confidence in converting decimal numbers to hexadecimal is quite high, with 45% of students strongly agreeing, but there are still 18% who disagree and 6% strongly disagree. Understanding in grouping binary digits when converting to octal shows that 40% of students strongly agree, while 18% disagree and 8% strongly disagree. Finally, in terms of converting octal numbers into binary form, 43% of students strongly agree with the statement, but there are still 18% who disagree and 10% who strongly disagree. These results indicate that while the majority of students have a good understanding of these concepts, there are still a number of students who need further help to master number conversion skills effectively.

3.3 Thematic Analysis of Interview Results

After analyzing the number conversion math test, scores were obtained in the highest, middle and low level categories. Next, the researcher chose one of the students from the highest, middle and lowest scores to conduct an in-depth interview about the number conversion mathematics TEST for these three students:

1) Initials AND (representative of students who get the highest score)
2) With the initials RDI (representative of students who obtained intermediate scores),
3) Initials VIN (representative of students who scored below)

With the aim of interviews to collect data from students about experiences in working on number conversion mathematical problems, as well as psychological factors that influence their performance

Table 3. Thematic Analysis Results of Interviews with Students After Taking the Number Conversion Mathematics Test

No	interview guidelines	AND respondents	RDI Respondents	Respondent VIN
1.	How do you feel about number conversion lessons in class? What do you like or dislike most about this topic?	I feel very enthusiastic about the number conversion lesson in class.	The number conversion lesson in class was quite challenging for me.	The number conversion lesson in class was very difficult for me.
2.	What steps do you take when converting a decimal number to octal or hexadecimal?	This topic is very interesting to me because it challenges my logic and analytical skills.	I like the challenge it provides, but sometimes find it difficult to understand some of the concepts.	I find it difficult to follow the steps that must be done.
3.	What is the most difficult part of the number conversion process you have ever experienced?	When converting a decimal number to octal or hexadecimal, I usually start by dividing the decimal number by the conversion base, then note down the remainder of the division from bottom to top.	The steps I take when converting a decimal number to octal or hexadecimal include dividing the decimal number by the desired base and recording the remainder of the division.	When converting decimal numbers to octal or hexadecimal, I am often confused by the process of dividing and recording the remainder.
4.	How do you read and understand number conversion problems?	The most difficult part of this process is ensuring there are no errors in manual calculations, especially when large numbers are involved.	The hardest part for me is maintaining accuracy so that there are no counting errors.	The hardest part is understanding the basic concept of the conversion itself.
5.	When you read a number conversion problem, what do you first look for or understand?	To read and understand conversions, I always look for keywords like “conversions” and requested base.	When reading a number conversion problem, I first find out the base used and the type of conversion required.	When reading a number conversion question, I tend to find out what type of conversion is required, but often feel confused about the steps to take.
6.	What do you usually do if you feel like you don't understand the	If there are instructions that I don't understand, I will look for	If I don't understand the instructions for a problem, I usually ask a friend or look	If I don't understand the instructions on a question, I usually

No	interview guidelines	AND respondents	RDI Respondents	Respondent VIN
	instructions on a question?	additional references or ask the teacher.	for an explanation in the textbook.	try to seek help from a friend or wait for further explanation from the teacher.
7.	How do you record the number conversion steps when working on a problem?	I note down each conversion step neatly in my notebook for easy double-checking.	I note down the conversion steps neatly on my worksheet for easy double-checking.	I note down the conversion steps simply on my paper, but often get confused when I have to double check.
8.	Have you ever experienced errors in writing conversion results? What usually causes it?	Mistakes in writing conversion results are often caused by fatigue or lack of focus, so I always try to remain fully concentrated.	Mistakes in writing conversion results often occur due to haste or lack of thoroughness.	Errors in writing conversion results are usually caused by my not understanding the correct steps.
9.	What strategies do you use to ensure that you record all the steps correctly?	My strategy for ensuring all steps are recorded correctly is to double check each step.	To ensure all steps are recorded correctly, I usually repeat the steps several times.	To make sure all the steps are recorded correctly, I try to be more focused and follow the examples given by the teacher.
10.	Can you explain how to represent decimal numbers in binary or octal form?	I can represent a decimal number in binary form by repeatedly dividing the decimal number by 2 and recording the remainder of the division.	I can represent decimal numbers in binary form by repeatedly dividing the decimal number by 2 and recording the remainder.	I have difficulty representing decimal numbers in binary or octal form without help because I don't understand the concept.
11.	Is there any part of the mathematical representation process that you find difficult? Why?	Difficulties usually arise with large numbers because they require more steps.	Difficulties often arise when it comes to converting very large numbers because it is easier to make mistakes.	The hardest part of this mathematical representation is making sure each step is done correctly, because I often have doubts.
12.	How do you ensure that the representation you use is correct?	To ensure my representation is correct, I always compare the conversion results with a tool or calculator.	To make sure my representation was correct, I compared it to the results from the calculator.	To ensure correct representation, I usually ask for help or check my results with a calculator.
13.	Are there certain things that make learning number	Learning number conversions becomes easier for	Learning number conversions is easier when there are	Learning number conversions is easier if there is

No	interview guidelines	AND respondents	RDI Respondents	Respondent VIN
	conversions easier or more difficult for you?	me when there are concrete examples and detailed explanations from the teacher.	visualizations or diagrams that help explain the process.	direct guidance and more detailed explanations.
14.	What do you think would help improve your understanding and ability in number conversions?	I believe that my understanding and abilities will improve with more practice and group discussions.	To improve my understanding, I feel that additional practice and more detailed explanations from the teacher would be very helpful.	I feel that more practice and one-on-one guidance from a teacher would really help improve my understanding.
15.	What advice do you have for your teacher or classmates to help you learn number conversions?	I advise teachers to give more practice questions and classmates not to hesitate to ask questions if something is not clear	I suggest teachers provide more example questions and classmates to frequently discuss the difficulties they face	My advice to teachers is to provide slower and clearer explanations, and for classmates to help each other in learning number conversions

3.4 Findings and Discussion

This research reveals various difficulties faced by class X students at SMKN 4 Pontianak in understanding number system conversions, both in terms of concepts, procedures and mathematical communication. Conceptual errors arise due to a lack of understanding of the basics of conversions such as repeated division with a certain base and the relationship of digits to exponents in binary and hexadecimal systems. For example, students often do not understand that converting a decimal number to binary requires repeated division by 2 and recording the result from bottom to top, or errors in grouping binary digits for conversion to octal and hexadecimal.

Procedural errors are seen when students make mechanical errors in calculations or grouping digits, such as incorrectly grouping binary digits when converting to octal or hexadecimal. For example, in converting the decimal number 255 to hexadecimal form, students often make mistakes in repeated division with base 16. Errors in exponent calculations also often appear, especially in problems that involve multiplying each binary digit by the corresponding power of two and adding the results, such as converting binary number 101110 to decimal form.

Mathematical communication errors, which include representation, reading, and writing, are also a significant problem. Many students have difficulty representing numbers correctly and systematically recording conversion steps. Mistakes in writing results or conversion steps often occur due to lack of understanding and thoroughness. For example, students often write down the conversion results incorrectly when converting the decimal number 123 into octal form or when grouping binary digits for conversion to hexadecimal.

The results of the questionnaire filled out by 32 students showed variations in their understanding and mathematical representation abilities. Most students have a good understanding of some concepts, such as converting decimal numbers to hexadecimal, but many still have difficulty understanding and applying basic concepts. As many as 45% of

students felt very confident in writing conversion steps clearly, but 30% of students showed significant uncertainty in documenting conversion results. The ability to avoid errors in writing conversion results also varied, with only 27% of students strongly agreeing that they could do it correctly.

Overall, these findings highlight the need for improvements in teaching methods and more effective approaches to help students understand basic number conversion concepts. More practice, detailed explanations, and one-on-one guidance from teachers are essential to improve students' understanding and skills in number conversion. With the right support, it is hoped that students can overcome these difficulties and achieve success in number conversion lessons.

Discussion of Research Results

This research reveals various difficulties faced by class X students at SMKN 4 Pontianak in understanding and applying number system conversions. These findings indicate fundamental problems in understanding concepts, conversion procedures, and mathematical communication skills including representation, reading, and writing.

1) Misconceptions:

The conceptual errors experienced by students show that many of them do not understand the basics of conversion between number systems well. For example, in decimal to binary conversion, students often do not understand that the decimal number needs to be repeatedly divided by 2, and the result is recorded as binary digits from bottom to top. Likewise, errors in decimal to octal and hexadecimal conversions indicate a lack of understanding of repeated division with bases 8 and 16, as well as grouping binary digits before conversion to octal or hexadecimal. These misconceptions indicate the need for more in-depth teaching about the basics of number systems and their conversions.

2) Procedural Error

Procedural errors made by students reflect problems in applying the correct conversion steps. Students often make mistakes in repeated division or exponential calculations. These errors are especially evident in multi-stage tasks, such as converting decimal numbers to binary, then to hexadecimal, where students often misgroup digits or perform erroneous calculations. This indicates that students need more practice and step-by-step guidance to understand and apply the conversion procedure correctly.

3) Mathematical Communication Errors

Students' mathematical communication skills, which include representation, reading, and writing, also show many weaknesses. Students often misrepresent conversion results and record the steps systematically. Errors in writing conversion results are often caused by misunderstanding and lack of accuracy. For example, students often write conversion results incorrectly when converting decimal numbers to octal or when grouping binary digits for conversion to hexadecimal. These errors indicate the need for more intensive practice and guidance in recording conversion steps clearly and accurately.

4) Questionnaire Results

The results of the questionnaire filled out by 32 students showed variations in their understanding and mathematical representation abilities. Although most students feel confident in some concepts, such as converting decimal numbers to hexadecimal, many still have difficulty understanding and applying other basic concepts. The significant level of uncertainty in documenting conversion results indicates the need for greater emphasis on the importance of systematically recording conversion steps.

5) Teaching Implications

These findings highlight the need for improvements in teaching methods for number system conversion. Teachers need to adopt more effective approaches, including providing more practice, more detailed explanations, and one-on-one coaching for students who are having difficulty. Using visualizations or diagrams can also help students understand the conversion process better. In addition, it is important for teachers to create a learning environment that supports discussion and collaboration between students to help each other and deepen their understanding.

6) Recommendation:

Based on these findings, several recommendations that can be given are:

1) More In-Depth Teaching: Teachers need to provide more detailed explanations of the basics of number system conversions, including repeated division and digit grouping.
2) More Practice: Students need more practical practice to master the conversion steps properly.
3) One-on-One Tutoring: Individual guidance from a teacher can help students who are having difficulty understanding the concepts being taught.
4) Use of Visualizations: Using diagrams or other visual aids can help students understand the conversion process more clearly.
5) Discussion and Collaboration: Encouraging discussion and group work among students can help them learn from each other and deepen understanding.

By implementing these recommendations, it is hoped that students' understanding and skills in number system conversion can increase, so that they can overcome the difficulties they face and achieve success in number conversion lessons.

IV. Conclusion

Based on the results of research through number conversion mathematical tests, the results of subject responses to questionnaires and interviews, it can be concluded:

1. Errors in understanding the concept of number conversion, including repeated division with a certain base and grouping of binary digits. Many students do not understand that to convert a decimal number to binary, it is necessary to repeatedly divide by 2 and record the result from bottom to top. Mistakes in understanding how to convert decimal to octal and hexadecimal also often occur, such as repeated division with base 8 or 16. In addition, students often make mechanical errors in calculations or grouping digits, such as grouping the binary digits required before conversion to octal or hexadecimal
2. Students' perceptions of the number conversion test, based on the results of the questionnaire, show that 25% of students strongly agree that they understand how to represent decimal numbers in binary form, while 36% disagree. For decimal to octal conversion, 36% strongly agreed and 12% strongly disagreed. Understanding of decimal to hexadecimal conversion is relatively high, with 45% strongly agreeing, but 18% disagreeing and 6% strongly disagreeing. When grouping binary digits for conversion to octal, 40% strongly agreed, while 18% disagreed and 8% strongly disagreed. Regarding octal to binary conversion, 43% strongly agreed, but 18% disagreed and 10% strongly disagreed. Levels of confidence in writing down conversion steps also varied, with 45% of students feeling very confident, but 30% indicating significant uncertainty in documenting conversion results. These results reflect the need for more effective teaching approaches and more practice to improve students' understanding and skills.
3. Mathematical communication errors include: representation, reading, and writing are significant challenges faced by students in number conversion. Many students have

difficulty representing numbers correctly and systematically recording conversion steps. For example, they often make mistakes when writing the results or steps for converting the decimal number 123 into octal form or when grouping binary digits for conversion to hexadecimal. Reading errors also often occur, where students do not understand the instructions or concept of repeated division that is required, such as when converting the decimal number 45 into binary form or repeated division with base 8 when converting the decimal 123 into octal form. Writing errors, caused by a lack of understanding and accuracy, are also common. These errors indicate the need for increased understanding and accuracy in the number conversion process.

Key findings include general difficulties in understanding and applying number conversion concepts, repeated errors in calculations, and variations in the effectiveness of evaluation methods. Psychological factors such as anxiety and self-confidence also influence student performance. Based on these findings, it is recommended to:

1. Increase the use of visual aids in learning to help students understand number conversions.
2. Provide additional practice focused on common mistakes that occur frequently.
3. Implementing more varied evaluation methods to accommodate various student learning styles.
4. Providing psychological support for students who show anxiety and lack of confidence in facing math problems.

References

Alifiani, I., Tyas, F. A., & Basir, A. (2022). Pemanfaatan Menu Equation & Symbol untuk Menulis Rumus Matematika pada Microsoft Power Point. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *4*(3). https://doi.org/10.20527/btjpm.v4i3.5768

Arif, M. T. (2019). Penelitian Evaluasi Pendidikan. *ADDABANA Jurnal Pendidikan Agama Islam*, *2*(2).

Biner, B. B., & Jme, H. B. (2010a). Program Diploma Iii Ilmu Komputer Basis Bilangan Biner , Oktal , Desimal , Dan Heksadesimal Berbasis J2Me. *Ilmu Komputer Basis Bilangan Biner , Oktal , Desimal , Dan Heksadesimal Berbasis J2Me*.

Biner, B. B., & Jme, H. B. (2010b). Program Diploma Iii Ilmu Komputer Basis Bilangan Biner , Oktal , Desimal , Dan Heksadesimal Berbasis J2Me. *Ilmu Komputer Basis Bilangan Biner , Oktal , Desimal , Dan Heksadesimal Berbasis J2Me*.

Candraningsih, Y., & Warmi, A. (2023). Kesalahan Siswa SMA dalam Menyelesaikan Soal Cerita Matematika berdasarkan Teori Newman. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *6*(1).

Charolina, S., & Hia, Y. (2022). Upaya Meningkatkan Pemahaman Konsep Matematika Siswa Dengan Model Pembelajaran Example Non-Example. *Journal Mathematics Education Sigma*, *3*(2).

Faiziyah, N., & Priyambodho, B. L. (2022). Analisis Kemampuan Berpikir Kritis Dalam Menyelesaikan Soal Hots Ditinjau Dari Metakognisi Siswa. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, *11*(4). https://doi.org/10.24127/ajpm.v11i4.5918

Gerson Feoh, S. K. (2011). Sistem bilangan dan konversi bilangan. *Sistem Bilangan Dan Konversi Bilangan*, *1*.

Gideon, A., Lestari, N., Bano, V., Sari, M., Wicaksono, D., Adriana, N., Mustafa, & Ibrahim, S. (2023). Metode Penelitian Pendidikan - Google Books. In *Jakarta: PT Kharisma Putra Utama*.

Gulo, F. (2016). Aplikasi Pembelajaran Konversi Bilangan Menggunakan Metode Computer Assisted Instruction (Cai). *Jurnal Riset Komputer (JURIKOM)*, *3*(6).

Hamdi, A. S. dkk. (2014). Metode penelitian kuantitatif aplikasi dalam pendidikan. In *Metode penelitian kuantitatif aplikasi dalam pendidikan*.

Jamal, F. (2022). Analisis Kesalahan dalam Menyelesaikan Soal Cerita Pertidaksamaan Kuadrat Berdasarkan Prosedur Newman. *Maju*, *5*(2).

Koch, K. (2024). National Education Standards. In *National Education Standards*. https://doi.org/10.4135/cqresrre19990514

Mufarokha, L. I., & Utami, R. (2022). Pengaruh Metode Kumon terhadap Kemampuan Pemahaman Konsep Kelas XI OTKP SMKN 1 Karangdadap. *Seminar Nasional Pendidikan Matematika*, *3*(1).

Muryadi, A. D. (2017). Model Evaluasi Program dalam Penelitian Evaluasi. *Jurnal Ilmiah PENJAS*, *3*(1).

Nasution, M. Z. (2019). Penerapan Principal Component Analysis (Pca) Dalam Penentuan Faktor Dominan Yang Mempengaruhi Prestasi Belajar Siswa (Studi Kasus : SMK Raksana 2 Medan). *Jurnal Teknologi Informasi*, *3*(1). https://doi.org/10.36294/jurti.v3i1.686

Nurizlan, A., Komala, E., & Monariska, E. (2022). Analisis Kesulitan Siswa dalam Menyelesaikan Soal Cerita pada Materi Trigonometri Ditinjau dari Langkah Polya. *PRISMA*, *11*(2). https://doi.org/10.35194/jp.v11i2.2530

Prakasa, D. P., & Ammamiarihta, A. A. (2023). Analisis Kemampuan Penalaran Matematis Siswa SMK Ditinjau dari Minat Belajar. *Euclid*, *10*(1). https://doi.org/10.33603/e.v10i2.8516

Rahma, A. F., & Khabibah, S. (2022). Analisis Kesalahan Siswa Sma Dalam Menyelesaikan Soal Eksponen. *MATHEdunesa*, *11*(2). https://doi.org/10.26740/mathedunesa.v11n2.p446-457

Riyanto, S., & Hatmawan, A. A. (2020). Metode Riset Penelitain Kuantitatif. In *Deepublish*.

Rizky Amalia, Makmuri, M., & Wijayanti, D. A. (2022). Pengembangan Buku Ajar Matematika dengan Pendekatan Kontekstual pada Materi Integral untuk Siswa SMK Bisnis dan Manajemen. *Jurnal Riset Pembelajaran Matematika Sekolah*, *6*(1). https://doi.org/10.21009/jrpms.061.07

ROCHIM, A. (2022). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Permutasi Dan Kombinasi Berdasarkan Kemampuan Matematika Di SMKN 1 Purwoasri. *EDUCATOR : Jurnal Inovasi Tenaga Pendidik Dan Kependidikan*, *2*(3). https://doi.org/10.51878/educator.v2i3.1637

Sahputra, Y. D., & Pramuditya, S. A. (2022). Analisis Kesulitan Belajar Siswa Pada Pemahaman Konsep Matematika Materi Limit Fungsi Aljabar Kelas XII Di SMK Manbaul Ulum. *Euclid*, *9*(2).

Sari, L. N. I., Ferdiani, R. D., & Yuwono, T. (2018). Analisis Kesalahan dalam Menyelesaikan Soal Cerita Berdasarkan Teori Newman. *Ibriez : Jurnal Kependidikan Dasar Islam Berbasis Sains*, *3*(1). https://doi.org/10.21154/ibriez.v3i1.48

Sriyeni, Y., & Veronica, M. (2019). Perancangan Antarmuka Aplikasi Konversi Bilangan dan Warna Berbasis Android. *Jurnal Ilmiah Informatika Global*, *10*(2). https://doi.org/10.36982/jiig.v10i2.855

Sugiyono. (2013). Metode Penelitian Pendidikan Pendekatan Kuantitaif, Kualitatif, dan R&DSugiyono. 2013. "Metode Penelitian Pendidikan Pendekatan Kuantitaif, Kualitatif, dan R&D." Metode Penelitian Pendidikan Pendekatan Kuantitaif,

Kualitatif, dan R&D. https://doi.org/10.1. *Metode Penelitian Pendidikan Pendekatan Kuantitaif, Kualitatif, Dan R&D*.

Sugiyono. (2019). Metode Penelitian Evaluasi. *Jurnal Penelitian Pendidikan*, *7*(1).

Surven, Sarumaha, A., & La'ia, H. T. (2022). Analisis Kemampuan Pemahaman Konsep Matematika Siswa Pada Materi SPLTV Kelas X SMK Negeri 1 Toma Tahun Pembelajaran 2021/2022. *AFORE : Jurnal Pendidikan Matematika*, *1*(1). https://doi.org/10.57094/afore.v1i1.434

Surya, S., Ikram, M., & Jumarniati, J. (2021). Kegagalan Dan Kesalahan Siswa Dalam Melakukan Translasi Antar Representasi Untuk Masalah Laju Perubahan. *LINEAR: Journal of Mathematics Education*. https://doi.org/10.32332/linear.v2i2.3737

Toriqularif, M. (2019). Penelitian Evaluasi Pendidikan. *Addabana: Jurnal Pendidikan Agama Islam*, *2*(2). https://doi.org/10.47732/adb.v2i2.122

Zulfikar, M. I., Mappeasse, M. Y., & Hasrul, H. (2022a). Pengembangan Media Pembelajaran Interaktif Berbasis Android Pada Materi Konversi Bilangan Digital. *Jurnal Media Elektrik*, *19*(2). https://doi.org/10.26858/metrik.v19i2.31526

Zulfikar, M. I., Mappeasse, M. Y., & Hasrul, H. (2022b). Pengembangan Media Pembelajaran Interaktif Berbasis Android Pada Materi Konversi Bilangan Digital. *Jurnal Media Elektrik*, *19*(2). https://doi.org/10.26858/metrik.v19i2.31526.