

Utilization of Problem-based Learning and Discovery Learning: The Effect of Elementary School Students' Capacity for Problem-Solving Based on Self-Efficacy

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ABSTRACT

Students today must have 21st-century skills to succeed in the workplace. Unfortunately, some students lack 21st-century skills due to an inefficient educational system. The study's overarching goal was to compare and contrast the student's capacity to solve problems exposed to Problem-Based Learning and those exposed to Discovery Learning, focusing on the relationship between the two in terms of the efficacy of students. A non-equivalent control group design with a quasi-experiment was utilized in the study. The simple random sampling technique was used, and fourth-grade elementary school students were chosen as the participant. The research sample was 96 students with one control and two experiment classes. There were two research instruments, namely the test and questionnaire for problem-solving and self-efficacy abilities. The data were analyzed using two-way ANOVA to show the differences in problem-solving abilities and self-efficacy taught by Discovery and Problem-based Learning. The findings of this study are supposed to serve as a guide for alternate teaching methods that can enhance students' problem-solving skills.

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1. INTRODUCTION

Education's function is very important for raising the standard of human resources. The education process needs to generate highly knowledgeable, competitive, creative individuals who have character so that the standard of human resources rises since this is in line with the legally mandated educational goals. A new age of education—the 21st century, often known as the industrial revolution—is beginning. 4.0, which is side by side with digital technology and 21st-century learning abilities. The 21st-century learning abilities, often known as the 4C, include abilities for critical and creative thinking, problem-solving, collaboration, and communication (Siregar & Rahmawati, 2020; Sugara & Mutmainnah, 2020; Valtonen et al., 2021). Therefore, so that Indonesian education does not lag behind other countries, students are expected to master these abilities.

One aspect that each student must possess to be able to have problem-solving and critical thinking abilities is the mental condition of students, students' self-efficacy in their abilities, especially regarding the material being studied, and students' success with difficulties depends on their ability to solve them. (Karaoglan Yilmaz, 2022; Saputra et al., 2021). According to Badura (2018), Hammer (2021), and Tan (2021), self-efficacy is the self-confidence that can affect problem-solving abilities, which are defined as individual confidence in solving problems from understanding concepts to solving problems. The capacity to resolve issues can help students make the right decisions carefully, systematically, and logically, and consider various points of view. However, the absence of these abilities results in students in the habit of doing multiple activities without knowing the goals and reasons for doing them (Foster, 2021; Fredagsvik, 2021; Sjöberg & Brooks, 2022). Simamora and Saragih (2019), in their research, said that self-efficacy has a role in shaping critical thinking and problem-solving abilities. This is consistent with what Psycharis, S., and Kallia, M., observed in their study (2017) which indicated that students' problem-solving skills and self-efficacy had a substantial correlation. According to the study's findings, problem-solving aptitude and self-efficacy are related. This shows that teachers are currently required to be able to develop lesson plans that can bring out students' 4C abilities.

But the truth is that students' capacity for problem-solving is still seen to be insufficient. Data from the Organization for Economic Co-operation and Development's (OECD) Program for International Student Assessment (PISA), in which Indonesia participated from 2000 to 2018, demonstrate that Indonesia is rated seventh from the bottom (73) in the mathematics category with an average score of 379, higher than Saudi Arabia, which has an average score of 373 (Tohir, 2019). Indonesian students do poorly on PISA due to students' poor mathematical problem-solving skills while responding to complex or non-routine problems (W. Amalia et al., 2018). Teachers must be creatively asked to apply suitable learning models to enhance students' problem-solving skills to solve these issues.

Discovery learning is a model that directs students to find the knowledge they want to convey in the learning (Chi et al., 2021; Latif, 2021; Yarni, 2019). With the concept of finding their knowledge, the Discovery Learning learning model directs students to solve the problems independently or in groups based on the information they learn through source books or other sources. This is comparable with the findings of Kholifah (2021), Saputri (2021), and Cholid (Cholid et al., 2022), which state that Discovery Learning is the lessons that are able to increase the ability to understand concepts and problem-solving and can be used to obtain positive responses from students.

Additionally, other instructional approaches, such as problem-based learning, can help students improve their problem-solving skills. In problem-based learning, real-world situations are used as the primary setting for teaching critical thinking and problem-solving techniques as well as foundational ideas and information from earlier modules (Suharini & Handoyo, 2019). Several studies support that the problem-based learning model can issue students' problem-solving abilities. In their study, Siagan et al. demonstrated that problem-based learning instructional materials satisfied successful criteria and enhanced the mathematical problem-solving (Siagan et al., 2019). According to Astriana et al. research, students' ability to solve mathematical problems is impacted by problem-based learning models

(Astriani et al., 2017). Additionally, Amalia et al.'s research demonstrates that adopting PBL to teach successfully increased students' capacity for solving mathematical problems (E. Amalia et al., 2017).

The impact of discovery learning and problem-based learning methods on problem-solving skills has been the subject of several research. In his study, Nahdi DS examined the effectiveness of guided discovery learning and problem-based learning strategies for solving problems (Nahdi, 2018). Safithri et al. examined the efficiency of project-based learning and problem-based learning models on problem-solving in terms of self-efficacy in their study (Safithri et al., 2021). Winoto & Prastyo, in their research, tested the effectiveness of discovery learning and problem-based learning models for problem-solving (Winoto & Prasetyo, 2020). Then, in his research, Mahmudah tested the effectiveness of discovery learning and problem-based learning models on students' critical thinking skills (Mahmudah, 2020).

From the data above, it can be seen that students' problem-solving abilities can be raised through the provision of appropriate learning models. Then research on student mentality, especially self-efficacy, also affects students' problem-solving abilities. In addition, from the data we obtained, testing between problem-solving and discovery learning models is only limited to seeing problem-solving or critical thinking skills without being reviewed from their self-efficacy. Therefore, the aim of this study is to investigate whether there are differences in the problem-solving skills of students who are taught using Problem-Based Learning and Discovery Learning and who have high, medium, and low self-efficacy, as well as whether there is an interaction between Problem-Based Learning, Discovery Learning, and students' self-efficacy towards students' problem-solving skills. The question that this study seeks to answer is: Is there a difference between problem-based learning and discovery learning in terms of how well students can solve problems? What about the relationship between self-efficacy and problem-solving skills?

2. METHODS

2.1. Research Design

In this study, quasi-experimental research was employed. When doing research that examines results between groups of interventions, individuals are not randomly assigned to the various interventions due to ethical or practical considerations (Andrade, 2021). Then, the experimental and control groups would each get a pre-test to ascertain the beginning condition of each group being treated. This study then employed a non-equivalent control group design. In Table 1, the research design is displayed.

Table 1. The research approach design

Category	Pre-	Treatment	Post-
Experiment Class I (Problem Based Learning)	O _{1A}	X _A	O _{2A}
Experiment Class II (Discovery Learning)	O _{1B}	X _B	O _{2B}
Control Class (Conventional)	O _{1C}	X _C	O _{2C}

2.2. Participants

All fourth-graders in State Elementary Schools in the Citapen region of the Bogor Regency made up the study's population. Furthermore, the sample selection used a simple random sampling technique and was carried out at SDN Citapen 01, Bogor Regency. A population of size N can be sampled using simple random sampling by assigning equal selection probability to each unit in the sample (Singh, 2003). The 96 students that made up the research sample were divided into three classes: the experimental class I (class IVA), the experimental class II (class IVB), and the control class (class IVC).

2.3. Data Collection

Pre- and post-tests on problem-solving abilities relevant to the sequences and series taught were used to gather the data. In order to gauge the problem-solving skills of students with high, medium, and low self-efficacy, the sample was first given a pre-test. After taking a pre-test, students were given the option to receive therapy in one of three experimental classes: class I would get problem-based learning, class II would receive discovery learning, and class III would receive traditional instruction. The entire learning process takes place in the classroom. The material of the sequences and series that had been presented was then connected to each class' performance on the post-test of problem-solving skills.

2.4. Research Instruments

In this study, a self-efficacy questionnaire, pre-test, and post-test of problem-solving skills using description questions were all employed as the instrument. Students are given a self-efficacy questionnaire before starting learning, and before the pre-test is carried out; after being given a self-efficacy questionnaire, students are given pre-test questions that contain prerequisite material from the material to be taught.

2.4.1. Self-Efficacy

The Self-efficacy indicators of this study referred to 3 dimensions: the level dimension, the generality dimension, and the strength dimension. Indicators of self-efficacy used in this study are displayed in Table 2.

Table 2. The Self-efficacy Indicators

Self-Efficacy Indicators	Questionnaire Statement Items
Students could complete assignments on time	1; 2; 3; 4
Students could motivate themselves to take the necessary actions to complete assignments	5; 6; 7; 8
Students are able to work hard, persistently, and diligently to complete assignments	9; 10; 11; 12
Students are able to face obstacles and difficulties in completing assignments	13; 14; 15; 16
Students are able to complete tasks that have a wide or urgent time span.	17; 18; 19; 20

Students were given a questionnaire with 20 items on it, and they had to select their response by marking each item on a 5-point Likert scale with 1 (Never), 2 (Rarely), 3 (Sometimes), 4 (frequently), and 5 (depending on their situation and viewpoint) (always).

2.4.2. Problem-Solving Ability

Four questions encompassing lesson material on different energy sources, changes in energy forms, and alternative energy sources (wind, water, sun, geothermal, organic fuels, and nuclear) in daily life were presented to participants as items on problem-solving skills. The instruments are shown in Table 3.

Table 3. Indicator of problem-solving skills

Problem-Solving Skills Indicator	Question Points
Students identify problems by understanding any given information.	1
Students make a problem-solving plan	2
Students carry out the problem-solving plan in a way that is considered the most appropriate.	3
Students re-correct the answers with confidence from the answers that have been described and recheck the answers.	4

2.5. Data Analysis

The results of a two-way ANOVA test were used in the data analysis. The use of Problem-Based Learning and Discovery Learning with self-efficacy on students' problem-solving skills was tested using a two-way ANOVA to see whether there was any interaction. The impact of therapy and self-efficacy on students' critical thinking abilities was then assessed using Tukey's subsequent test.

3. FINDINGS AND DISCUSSION

3.1. Findings

3.1.1. Tests of research instruments

The results of the validity assessment of the self-efficacy statement of the survey indicate that each item's r count is displayed in Table 4.

Table 4. The result of the self-efficacy questionnaire's validity

Item	r_{count}	r_{table}	Result
1.	0.640	0.3061	v
2.	0.590	0.3061	v
3.	0.510	0.3061	v
4.	0.530	0.3061	v
5.	0.670	0.3061	v
6.	0.420	0.3061	v
7.	0.670	0.3061	v
8.	0.540	0.3061	v
9.	0.570	0.3061	v
10.	0.583	0.3061	v
11.	0.679	0.3061	v
12.	0.539	0.3061	v
13.	0.500	0.3061	v
14.	0.487	0.3061	v
15.	0.583	0.3061	v
16.	0.500	0.3061	v
17.	0.583	0.3061	v
18.	0.679	0.3061	v
19.	0.539	0.3061	v
20.	0.524	0.3061	v

Information:

V= valid

I=invalid

The results of Table 4 show that the 20 items from the Self-Efficacy statement have a higher r_{court} than the r_{table} . This shows that the Self-Efficacy statement used was valid

Table 5. The results of the self-efficacy questionnaire reliability test

Case Processing Summary			
		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
	Total	30	100.0

Reliability Statistics	
Cronbach's Alpha	N of Items
.928	20

Table 5 shows that 20 questions with a Cronbach's Alpha score of $0.928 > 0.60$ were presented to 30 students. It is possible to infer that 20 questions, or all questionnaire items for self-efficacy, are reliable based on the fundamental study of decision-making in the reliability test described above. The validity and reliability of the instrument are described in Table 6.

Table 6. Results of problem-solving ability tests for validity and reliability

	Correlations	Item 1	Item 2	Item 3	Item 4	Item 5	Total
Item 1	Pearson Correlation	1	.902**	.869**	.759**	.811**	.914**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	100	100	100	100	100	100
Item 2	Pearson Correlation	.902**	1	.922**	.856**	.904**	.921**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	100	100	100	100	100	100
Item 3	Pearson Correlation	.869**	.922**	1	.785**	.787**	.930**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	100	100	100	100	100	100
Item 4	Pearson Correlation	.759**	.856**	.785**	1	.825**	.914**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	100	100	100	100	100	100
Total	Pearson Correlation	.914**	.981**	.930**	.914**	.930**	.927
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	100	100	100	100	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

Reliability Statistics	
Cronbach's Alpha	N of Items
.914	4

The problem-solving instrument was tested on 30 students. The results of the analysis of the instrument test show that item 1 item gets a result of 0.921, item 2 gets a result of 0.930, item 3 gets a result of 0.914, and the item item item 4 gets a result of 0.927. The SPSS results above show a significant Pearson correlation value of < 0.01 . For each item value for each item ($\alpha = 0.05$) it can be concluded that the instrument is valid and reliable.

3.1.2. Examination of the pre-test data for students' normality and homogeneity

Students were given a self-efficacy questionnaire to identify where each student in the experimental class and control class fell on the self-efficacy scale before Problem-Based Learning and Discovery Learning were introduced. Five students in experimental class I had high self-efficacy categories, 23 had intermediate categories, and three had poor categories, according to an analysis of the student self-efficacy questionnaire. Ten students in experimental class II fell into the high self-efficacy group, 19 fell into the moderate self-efficacy category, and two fell into the low self-efficacy category, compared to five in the control class, fifteen in the medium category, and twelve in the low self-efficacy category. Students were given a questionnaire before taking a pre-test to determine. Students were given a self-efficacy questionnaire to identify where each student in the experimental class and control class fell on the self-efficacy scale before Problem-Based Learning and Discovery Learning were introduced. Five students in experimental class I had high self-efficacy categories, 23 had intermediate categories, and three had poor categories, according to an analysis of the student self-efficacy questionnaire. Ten students in experimental class II fell into the high self-efficacy group, 19 fell into the moderate self-efficacy category, and two fell into the low self-efficacy category, compared to five in the control class, fifteen in the medium category, and twelve in the low self-efficacy category. Students were given a questionnaire before taking a pre-test to determine.

Table 7. Student pre-test normality test results

Category	Shapiro-Wilk		
	Statistic	Df	Sig.
Experimental I	0.97	31	0.73
Experimental II	0.96	31	0.33
Control	0.95	31	0.26

According to Table 7, the experimental classes I and II each achieved a significant value of $0.73 > 0.05$, $0.33 > 0.05$, and $0.26 > 0.05$ respectively, while the control class also achieved a significant value of $0.26 > 0.05$. The pre-test value data for the experimental classes I and II and the control class may be inferred to be regularly distributed.

Table 8. Student pre-test homogeneity test results

Levene Statistic	df1	df2	Sig.
140	2	91	0.86

According to Table 8's homogeneity test findings, the data of the students' pre-test results have the same variance or are homogenous if the significance value is more than 0.05.

3.1.3. Examination of the Post-Test Data for Students' Normality and Homogeneity

Following the pre-test, PBL learning was implemented in experimental class I, discovery learning in experimental class II, and traditional learning in the control class for each class. The same treatment is offered to all students (there is no difference between students with high, medium, and low self-efficacy). The instructor used an observation sheet to track how the researchers' and students' tasks were carried out. Students took a post-test after participating in the experimental and control groups and scoring well on the markers of problem-solving skills. The exams were identical (there was no difference in treatment between students who had high, medium, and low self-efficacy).

The findings of the students' post-test were also subjected to normality and homogeneity tests. Table 9 displays the outcomes of the normality test performed on the post-test data for the student.

Table 9. Student post-test normality test results

Category	Shapiro-Wilk		
	Statistic	Df	Sig.
Experimental I	0.93	31	0.18
Experimental II	0.96	31	0.42
Control	0.91	31	0.20

The experimental class I achieved a significant value of $0.18 > 0.05$, the experimental class II obtained a significant value of $0.42 > 0.05$, and the control class acquired a significant value of $0.20 > 0.05$, as shown in the post-test normality test results table. The post-test value data for the experimental classes I and II and the control class may be inferred to be regularly distributed.

Table 10. The outcome of the student post-test homogeneity test

Levene Statistic	df1	df2	Sig.
0.48	2	91	0.64

Table 10 shows a significance value > 0.05 , which indicates that the data of the students' pre-test scores have the same or homogeneous variance.

3.1.4. Tests of Hypothesis: Results

The learning model's impact on students' problem-solving abilities and the impact of students' self-efficacy on those abilities were the two variables that were examined to determine whether there were any significant differences using the Two Way ANOVA test and Tukey additional test. Table 11 displays the outcomes of the Two Way ANOVA test used to evaluate hypotheses.

Table 10. Two-way ANOVA test results

Source	F	Sig.
Corrected Model	26.61	.000
Intercept	3870.5	.000
Metode	25.02	.000
SE	21.64	.000
Metode*SE	1.72	.153
Corrected Total	93	

Table 11 shows that the significant value for the learning model is $0.00 < 0.05$, indicating that integrating Problem-Based Learning and Discovery Learning has an impact on students' ability to solve problems. Additionally, because student self-efficacy has a significance value of $0.00 < 0.05$, it can be said that it has an impact on students' capacity for problem-solving. Additionally, the model's significant value for self-efficacy is $0.153 > 0.05$, indicating that there is no interaction between student self-efficacy and the application of problem-based learning and discovery learning on students' problem-solving skills. A second test was conducted to determine the extent to which the impact of students' treatment and self-efficacy on their capacity for problem-solving (Tukey). Results from the learning Tukey's test.

Table 11. Tukey further tests the variable learning method

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
DL	PBL	-4.52	3.141	.372	-8.69	1.59
	CL	18.61	3.122	.000	14.63	24.8
PBL	DL	4.52	3.141	.372	-1.59	8.69
	CL	23.44	3.104	.000	18.15	28.3
CL	DL	-18.13	3.118	.000	-2.80	-14.6
	PBL	-24.19	3.135	.000	-28.35	-18.1

Information:

DL : Discovery Learning

PBL : Problem-based Learning

CL : Conventional Learning

Table 12 demonstrates that students who are taught using Problem-Based Learning have a problem-solving skill that is 4.52 points higher than students who are taught using Discovery Learning. Kids who get problem-based learning instruction have a problem-solving skill that is 24.19 points higher than students who receive traditional instruction. Additionally, students who are taught using problem-based learning have a 24.19 improvement in their ability to solve problems compared to those who are taught using traditional methods. Additionally, the self-efficacy variable on students' problem-solving skills was tested using Tukey's additional test, the results of which are shown in Table 13.

Table 12. Tukey advanced test results of self-efficacy

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Intermediate	11.81	2.24	.000	6.51	17.12
	Low	32.21	2.83	.000	25.53	39.06
intermediate	High	-11.81	2.24	.000	-17.12	-6.41
	Low	20.62	2.34	.000	14.95	26.12
Conventional	High	-32.31	2.83	.000	-39.10	-25.56
	intermediate	-20.53	2.34	.000	-26.21	-14.96

Table 12 demonstrates that students with high self-efficacy have a problem-solving skill that is 11.81 times larger than students with moderate self-efficacy. Students with strong self-efficacy are better at solving problems than students with low self-efficacy, with a difference of 32.21. Additionally, students with intermediate levels of self-efficacy have a problem-solving capacity that is 20.62 points higher than students with low levels of self-efficacy.

The findings of the two-way ANOVA conducted on the post-test scores of students' problem-solving skills after they had been exposed to problem-based learning, discovery learning, and traditional learning demonstrate that H₀ is accepted. The use of problem-based learning and discovery learning has an impact on students' ability to solve problems; the significance is 0.00 0.05, to put it another way.

3.2. Discussion

Theoretical underpinnings for Problem-Based Learning and Discovery Learning are provided by constructivist theories of learning, which place emphasis on the requirement for students to research their surroundings and create their own knowledge (Eun, 2019; Kirom, 2017; Ozdem-Yilmaz & Bilican, 2020; Silalahi, 2019; Simamora & Saragih, 2019; Xi & Lantolf, 2021). Several constructivist theories, namely Piaget with his cognitive theory, Vygotsky with the concept of the zone of proximal development, and Brunner, namely the theory of scaffolding, also strengthen this research.

This is consistent with the findings of Yerizon (2021), Febrian and Delyana (2020), and Pandiangan (2020), which state that the PBL model's implementation can help students become better problem-solvers since it requires them to seek solutions, which can help students evaluate their problem-solving skills. They will also get problem-solving training, with the difficulties that are given during the learning process mirroring actual problems encountered in daily life. Then the research results by Lutfi (2019), Nurdiana (2019), and Abdi (2021) show that the application of discovery learning with groups effectively develops students' problem-solving abilities. Students who get discovery learning have a higher outcome value than those who get conventional education. Discovery learning helps students find answers, explore knowledge and experience, and feel responsible for the results. In addition, Discovery Learning fosters students' confidence to be actively involved in question-and-answer sessions.

According to this study, students who were taught using problem-based learning had a problem-solving skill that was 4.52 points higher than students who were taught using discovery learning. Kids who get problem-based learning instruction have a problem-solving skill that is 24.19 points higher than students who receive traditional instruction. Based on research results, Buana (2020) and Hanum (2019) support the results of this study which state that Problem-Based Learning is more effective than the Discovery Learning model in improving problem-solving abilities. Problem-Based Learning helps students build reasoning and communication to develop higher-order thinking skills such as critical thinking, finding and using learning resources, working cooperatively, and learning for life. Problem-Based Learning in its implementation, learning a problem through a close environment is structured so that students can think critically and can solve the problems given to them. Meanwhile, in Discovery Learning, the material provided is not in complete form. Students are guided to locate and comprehend topics by the fundamental skills to be attained in the learning resources (Hanum et al., 2019; Kartika & Harjono, 2020; Putri et al., 2020). Therefore, Problem-Based Learning can be used as a reference for improving students' problem-solving abilities.

Following the teaching of problem-based learning, discovery learning, and conventional learning, the findings of a two-way ANOVA on the post-test results of problem-solving abilities reveal that there is a significant difference in problem-solving abilities. The significance value is 0.00 0.05. Considering students with high, medium, and low levels of self-efficacy. Students with high levels of self-efficacy are 11.81 more capable of addressing problems than students with moderate levels of self-efficacy. The capacity of students with high self-efficacy to solve problems is 32.21, which is higher than the ability of students with low self-efficacy to solve problems. Additionally, students with intermediate self-efficacy are 20.62 more capable of addressing problems than students with low self-efficacy. The results of a post-test on students' problem-solving skills and self-efficacy in the experimental classes I and II as well as the control class demonstrate that there is no interaction between the use of Problem-Based Learning and Discovery Learning and students' problem-solving abilities. Self-efficacy is an inherent factor that students already possess before receiving therapy to overcome any barriers, which explains why. When descriptive statistics are calculated for each group, students with high self-efficacy outperform students with moderate and low self-efficacy in terms of their average problem-solving skill score. Thus, self-efficacy has a significant influence on students' problem-solving abilities. The findings of this study are supported by research by Utami (2017) and Somawati (2018), which shows that problem-solving has a substantial impact on self-efficacy. Accordingly, the more self-efficacy a student has, the simpler it is for them to solve difficulties.

4. CONCLUSION

Based on the findings and discussions presented, it is possible to draw the following conclusions: (1) there is a relationship between the use of Problem-Based Learning and Discovery Learning and students' problem-solving abilities; (2) there is a relationship between student self-efficacy and students' problem-solving abilities; and (3) there is no relationship between the use of Problem-Based Learning, Discovery Learning, and conventional learning and students' self-efficacy. This is because there is no contact with students' problem-solving skills, which each student already possessed prior to receiving instruction and teaching methods from the teacher. The findings of this study suggest that problem-based learning and discovery learning be used by teachers to help students improve their problem-solving abilities. The instructor must, however, also be responsible for the classroom's setup, infrastructure, and overall condition. There are some drawbacks to this study, especially the learning themes chosen to maintain a moderate level of student excitement.

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