Teaching and Learning Electricity—A Study on Students' and Science Teachers' Common Misconceptions

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ABSTRACT

The presence of misconceptions about electricity among students can hinder learning it, more so if the science teachers themselves have these misconceptions. This study aimed to determine the most common misconceptions about electricity among students and science teachers to shed light on this problem. The study utilized a descriptive research design involving the administration of the Simple Electric Circuit Diagnostic Test (SECDT), a written test to survey the students and teachers' misconceptions about electricity, and a semistructured interview of students to confirm the results of this test. Based on the results, students and science teachers share some common models of misconceptions about electricity like the clashing current, shared current, current flow as water flow, short circuit, and local reasoning models. In addition, the paper found out that students and science teachers manifested a lack of knowledge on many SECDT items. Results of the interview confirmed consistency in the answers of the students in the test. The researchers recommend using different strategies to improve the students' and teachers' conceptual understanding of electricity to address these misconceptions and lack of knowledge.

Keywords: electricity, lack of knowledge, misconceptions, misconception models, SECDT

INTRODUCTION

The Department of Education (DepEd; 2013) mandates that the 21st-century Filipino learners develop effective communication, life and career, learning and innovation, and information, media, and technology. The DepEd (2013) believes that these skills are necessary to prepare students for employment, entrepreneurship, middle-level skills development, and higher education. Subsequently, the Philippine K–12 Curriculum is focused on these goals that it has implemented various programs across all learning areas, including science.

In the science subject, especially in physics, students and teachers experience difficulties in learning and teaching. Subsequently, the Philippines scored significantly worse than any other country in the 2019 Trends in International Mathematics and Science Study (TIMSS). The result is considered the lowest among all 58 participating countries for both tests (Bernardo, 2020).

With this result, one of the main problems in the learning process of physics was found out to be the presence of misconceptions among the students (Wijaya et al., 2016). Kaltakci and Didis (2007) defined misconceptions as stable and unscientific students' conceptions that hinder the correct learning of concepts. These misconceptions are present in all educational and cultural backgrounds (Widodo et al., 2018). Meanwhile, Samsudin et al. (2018) defined misconceptions as understanding concepts that are not appropriate with the correct scientific conceptions. Turgut et al. (2011) mentioned that misconceptions deeply penetrate a student's mind and that the student tends to resist changing them. The student's personal experiences, language used, textbooks, and even teachers were the primary sources of misconceptions (Hammer, 1996). These misconceptions are common in physics, specifically in electricity, because of its abstract nature. For students to learn scientific concepts effectively, they must overcome misconceptions. Also, teachers should eliminate misconceptions that the students can have formed even before formal teaching. Furthermore, students should be able to distinguish misconceptions from lack of knowledge. Students' failure to understand basic electrical concepts can result from a lack of confidence in what they know about them.

Hence, the researchers conducted this study to determine Grade 9 students' and science teachers' misconceptions about electricity.

Specifically, the researchers aimed to answer the following:

1. What are the most common misconceptions of students about electricity?
2. What are the most common misconceptions of science teachers about electricity?

The study is focused on students' and science teachers' misconceptions about electricity. In addition, the present study also recorded their lack of knowledge of some electrical concepts like items about current and resistance in series and parallel circuits. As a limitation, this study did not include correct conceptions about electricity among students. Exploring the possibility of direct effects of teachers' misconceptions on the students was not a part of this research. Teachers were not interviewed to confirm their answers due to their unavailability.

The study results will benefit all stakeholders in education to determine points of improvement in teaching electricity. The findings can also spark more studies that will better understand this problem in the broader setting.

MATERIALS AND METHODS

Preparations

The study utilized a descriptive research design to investigate students' and teachers' misconceptions in basic electric circuit concepts. According to Fluet (2021), the descriptive design aims to describe the characteristics of a given sample. The study included data gathered from teachers' and students' misconceptions about electricity. Afterward, the students' responses were used in confirming their misconceptions through a semistructured interview. However, interviews were not performed with the teachers due to their unavailability brought by their busy schedules.

The participants of the study consisted of 358 Grade 9 students and eight science teachers from two public high schools in the National Capital Region in the Philippines. The researchers chose these schools because of their proximity. Grade 9 students were chosen since these students already underwent lessons on basic concepts of electricity, especially lessons on electric circuits, in their Grade 5 and 8 science subjects. Hence, Table 1 shows the distribution of participants from the schools involved. The teacher-participants must have taught Grade 7 and 8 science at most since the last school year. It is also because basic concepts of electricity in the junior high school level are part of the Grade 7 and 8 science curricula. They have already experienced delivering instruction for the topics concerned. It was reported that of the eight teachers involved in the study, only one is a physics major, while the other seven are from different fields of science education. Purposive sampling was employed to gather data from the desired participants of the study.

Table 1. Participants of the Study.

Participants	Students	Teachers
School A	157	4
School B	201	4
School C	358	8

For surveying misconceptions in electricity, the researchers adopted the Simple Electric Circuit Diagnostic Test (SECDT) developed by Pesman and Eryilmaz (2009). The instrument measured 11 misconception models. These models and their descriptions are shown in Table 2. This test is made up of 12 items about the basic concepts of electricity and electric circuits. A certain combination of answers from the first and second tiers per item while answering "sure" in the third tier can constitute a certain model of misconception depending on the combination of answers. Any combination of answers from the first and second tiers while answering "not sure" in the third tier corresponds to a "lack of knowledge." Correct answers with the participants' certainty of their answers and other combinations of answers not constituting a specific misconception, including false positives and negatives, were not recorded in the study.

Table 2. Misconception Models Measured by the SECDT.

Model of Misconception	Description
Sink	Only a single wire connection between an electric device and a power supply can run a
Attenuation	Current decreases as it travels in a circuit.
Shared current	Current is shared equally by electrical devices.
Sequential reasoning	A change at a point in a circuit affects it forward in the direction of the current, not
Clashing current	The clashing of the positive and negative charges from the source runs the device.
Empirical rule	The farther the bulb from the battery, the dimmer it is.

Short circuit	Wires with no electrical devices are ignored in circuit analysis.
Power supply as constant current source	A power supply provides the circuit a constant current rather than electrical energy.
Parallel circuit	An increase in the number of resistors in parallel increases the circuit's resistance.
Local reasoning	In a change in a local part of a circuit, the local part is focused instead of the whole circuit.
Current flow as water flow	Current flow in a wire is like water flow in a pipe.

Each item in the SECDT can assess one or more misconception models. A combination of answers in the item can constitute a certain model. Table 3 shows these combinations. The researchers used the misconception score and the percentage to describe how prevalent the misconception models are among the students and the teachers.

Table 3. Combination of Responses in the SECDT Constituting Misconception Models.

Model of Misconception	Choice Combinations Representing Misconceptions
Sink	1.1 a, 1.2 a, 1.3 a; 10.1 a, 10.2 b, 10.3 a; 10.1 b, 10.2 b, 10.3 a
Attenuation	4.1 c, 4.2 c, 4.3 a; 4.1 b, 4.2 c, 4.3 a
Shared current	3.1 b, 3.2 c, 3.3 a; 3.1 a, 3.2 c, 3.3 a; 4.1 d, 4.2 c, 4.3 a; 5.1 b, 5.2 c, 5.3 a; 5.1 a, 5.2 c, 5.3 a
Sequential reasoning	9.1 a, 9.2 a, 9.3 a; 9.1 c, 9.2 b, 9.3 a
Clashing current	1.1 b, 1.2 b, 1.3 a; 10.1 a, 10.2 a, 10.3 a
Empirical rule	4.1 b, 4.2 a, 4.3 a; 7.1 b, 7.2 b, 7.3 a; 12.1 a, 12.2 b, 12.3 a
Short circuit	8.1 b, 8.2 b, 8.3 a; 8.1 c, 8.2 c, 8.3 a; 10.1 a, 10.2 c, 10.3 a; 12.1 b, 12.2 d, 12.3 a
Power supply as constant current source	3.1 c, 3.2 a, 3.3 a; 3.1 a, 3.2 a, 3.3 a; 5.1 c, 5.2 e, 5.3 a; 9.1 d, 9.2 d, 9.3 a
Parallel circuit	5.1 a, 5.2 a, 5.3 a
Local reasoning	2.1 a, 2.2 a, 2.3 a; 5.1 a, 5.2 b, 5.3 a; 12.1 a, 12.2 c, 12.3 a
Current flow as water flow	6.1 a, 6.2 a, 6.3 a; 7.1 c, 7.2 a, 7.3 a; 11.1 a, 11.2 b, 11.3 a

The sink model was used as an example to describe how to get the misconception score per model. It is measured by two items, 1 and 10. In item 1, there is only one possible combination of answers that constitutes the sink model. The researchers recorded how many participants gave this combination. Meanwhile, in item 10, there were two possible combinations of answers. The researchers recorded the number of participants who answered each combination. Then, the total of these was recorded to get the number of students who manifested the sink model of misconception in item 10. Then, this value and the number of participants who recorded a misconception under the sink model in item 1 were averaged. This average score is the misconception score of the participants in the sink model. The percentage is obtained by dividing this score by the total number of participants. The same mechanism is used to get the misconception scores for the other models. The proponents of the SECDT did not prescribe a range of scores for interpreting the results of the instrument.

The SECDT has a Cronbach's alpha reliability coefficient of .69. It means that the instrument is a valid and reliable measure of students' understanding and misconceptions about electric circuits. Meanwhile, Table 4 below shows that the SECDT has face validity. The items in the instrument are within the content standards and learning competencies set in electricity by the DepEd for Science 5 and 8. It is during these grade levels where basic concepts about electric circuits were discussed. Basic concepts in constructing a circuit and the changes that can happen due to adding or removing bulbs (and thus resistances) are discussed in Grade 5. Meanwhile, these concepts are further elaborated in Grade 8 with discussions about series and parallel circuits and the relationship of current, voltage, and resistance in these circuits. Also, topics on the safety of home circuitries are discussed, which include topics like short circuit and overloading.

Table 4. SECDT Topics and DepEd Content Standards and Learning Competencies (LCs) for Grade 5 and 8 Electricity.

SECDT Topics	Content Standards	LCs for Electricity
— How to construct a circuit — Current in a series and parallel circuit — Total resistance in a circuit — Short circuit	For Grade 5 — a simple DC circuit and the relationship between electricity and magnetism in electromagnets	For Grade 5 — infer the conditions necessary to make a bulb light up — determine the effects of changing the number or type of components in a circuit
	For Grade 8 — current–voltage–resistance relationship, electric power, electric energy, and home circuitry	For Grade 8 — infer the relationship between current and charge — explain the advantages and disadvantages of series and parallel connections in homes — explain the functions of circuit breakers, fuses, earthing, double insulation, and other safety devices in the home

Data Gathering

The researchers sought consent from the school administrators, teachers, parents, and participants for the study. All participants were informed that all personal information gathered during the conduct of the study was treated with confidentiality.

After this, the researchers administered the SECDT to the students through their teachers. They administered the instrument to the students during their one-hour class. Upon collecting papers, the researchers recorded the gathered data and determined the most common misconceptions of students about electricity and the number of responses by students that constituted a lack of knowledge on the questions asked in the test.

Upon recording all responses regarding students' misconceptions, 12 students with the highest number of misconceptions recorded underwent a semistructured interview to confirm the results. Six students from each school were chosen. These students were asked two questions related to the most common misconception determined in the study and were given the same diagram used in the test. They were not informed of their answers in the written SECDT. Data from this were analyzed through content analysis of the students' responses. The researchers determined if the students were consistent with their answers in the test and the interview. If there is an inconsistency in the answers, the researchers tried to determine the factors that caused the inconsistency.

Afterward, the science teachers were given the same test. The researchers left the instrument to the teachers to answer it at their most convenient time due to their busy schedules. After the test was retrieved, the data were recorded the same way how students' misconceptions were recorded. The results of the students' and teachers' misconceptions were compared to elicit many implications. Teacher interviews were scheduled but not fulfilled due to the unavailability of the teachers because of their busy schedules.

RESULTS AND DISCUSSION

Students' Common Misconceptions

The SECDT was administered to the students to determine their misconceptions. Table 5 shows the most prevalent misconceptions of the participating students about electricity. The misconception scores for each model of misconception and the percentage were given.

Table 5. Students' Misconceptions About Electricity.

Model of Misconception	Score	Percentage (%)
Clashing current	135.0	37.7
Short circuit	56.0	15.6
Empirical rule	43.7	12.2
Shared current	43.3	12.1
Local reasoning	42.0	11.7
Current flow as water flow	36.3	10.2
Sink	28.0	7.8
Attenuation	12.0	3.4
Sequential reasoning	11.0	3.1
Parallel circuit	10.0	2.8
Power supply as a constant	6.7	1.9

The data show that the most common misconception of students about electricity falls under the clashing current model with a 135.0 or 37.7% score. The results prove that the most common misconception of students in electricity is that a power supply in a circuit supplies positive and negative electricity in a device. In addition, they believe that their clashing causes it to run (Chambers & Andre, 1997; Sencar & Eryilmaz, 2004; as mentioned in Pesman & Eryilmaz, 2009). It is instead of believing that a device connected in a circuit will run due to the flow of electrons in a circuit caused by a potential difference provided by a voltage source.

The other common misconceptions of students about electricity are under the short circuit, empirical rule, shared current, local reasoning, and current flow as water flow models with percentages of more than 10% of the students.

These results are comparable to the findings of Pesman and Eryilmaz (2009) with high school students. Their results showed that, similar to this study, the shared current, clashing current, short circuit, and local reasoning models were common misconceptions of their study respondents. The only model that was prevalent in their study but was not a common misconception of the respondents of this study was the power supply as a constant current source model. This model was the least common misconception of students participating in this study, with only 1.9% answering a set of responses constituting this model.

In addition, the results are also comparable to the findings of the study of Widodo et al. (2018). In their study, only 17% of the participants showed that they have a right conception about electricity, specifically parallel circuits. The rest manifested misconceptions. Other studies showed that the attenuation model is also a common misconception among students. For example, the participating students in the study of Turgut et al. (2011) had a misconception that as current flows through a circuit, the bulbs in it consume the current. In the study of Samsudin et al. (2018), they found out that 39.8% of the students participating in their study experienced misconceptions about electricity before administering a computer simulation that uses the Predict, Discuss, Explain, Observe, Discuss, Explain or PDEODE learning model to address the misconceptions. After this treatment, a reduction in the occurrence of these misconceptions was recorded.

Meanwhile, Table 6 shows the number of students who gave a “not sure” response in the third tier of the test items in the SECDT. The students' responses manifested a lack of knowledge of the questions asked, resulting in their lack of confidence in their answers.

Table 6. Rate of Lack of Knowledge of Students in the SECDT Items.

Item – Topic Asked	Number of "Not Sure" Responses	Percentage (%)
1 – How to construct a circuit	67	18.7
2 – Current in a parallel circuit	162	45.3
3 – Current in a series circuit	165	46.1
4 – Current in a series circuit	167	46.7
5 – Total resistance in a circuit	163	45.5
6 – Current in a parallel circuit	193	53.9
7 – Current in a parallel circuit	152	42.5
8 – Short circuit	143	39.9
9 – Total resistance in a circuit	200	55.9
10 – How to construct a circuit/short circuit	119	33.2
11 – Current in a parallel circuit	183	51.1
12 – Short circuit	149	41.6

The table shows a lack-of-knowledge rate higher than 40% for all items. The result excludes the 1st and 10th items (item 8 is at 39.9%). Items 1 and 10 are both about how to construct an electric circuit. It shows that the students showed greater confidence in their answers to questions about this topic. However, the high rate of misconception on the clashing current model means that even if they are confident about their knowledge of circuit construction, 37.7% of them have a wrong conception of how current flows in a circuit.

The higher rates of lack of knowledge on the other 10 items show the students' lack of confidence in answering these questions. It is an alarming result considering the students underwent lessons about basic electricity in their previous grade levels. It can also explain why the percentages of misconceptions are quite low (the highest percentage of misconception model was 37.7%, with the next highest being at 15.6% already). It means that students are more likely not knowledgeable about certain concepts in electricity rather than having misconceptions about the same.

The percentages of lack of knowledge are at the highest in items number 9 (55.9%), number 6 (53.9%), and number 11 (51.1%). These items are related to each other, with both items 6 and 11 asking about current in a parallel circuit. Meanwhile, item 9 compares the resulting current on a series circuit when different resistances are connected. These results are similar to Pesman and Eryilmaz's (2009) findings, where they also had item number 9 with the highest number of responses constituting a lack of knowledge by the students. They explained that it could be because students did not commonly encounter the questions in answering tests in electricity. The high rate of lack of knowledge on parallel circuits can be why the misconception under the parallel circuit model is less prevalent in students at only 2.8%.

These results are also comparable to the findings of Samsudin et al. (2018). They found out that 27.4% of the participating students in their study did not understand the topics in electricity while 25% manifested only a partial understanding.

On the other hand, item number 1 has the lowest occurrence of lack of knowledge for students. The diagram (shown in Figure 1) for the item is very clear and distinguishable in daily life compared to the other diagrams given in the instrument. The other figures are more complicated and require the students to make a deeper analysis while answering.

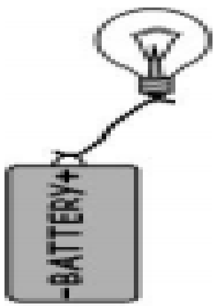

Figure 1. The given figure for item 1 of the SECDT.

A semistructured interview of the 12 students, 6 from each school, who recorded the highest number of misconceptions confirmed the results. Since the most common misconception recorded was the clashing current model, two questions that measure this model were again given to the students. They were asked to give their reasons for their answer to see if the clashing current model is manifested in their explanation. The two questions asked were items 1 and 10. They have their figure that the students will analyze. Both items ask if the light bulb in the given circuit setup will light up.

The students' answers in the interview were found to be consistent with the results. The interviewees' answers reflect the most prevalent misconception of students about electricity: the belief that current is the product of the interaction or clashing of electric charges in the circuit. For example, student 8 said that the circuit in item 1 would not light up because "*the wire is only in the positive.*" He added that the wire "*needs to be on both sides, positive and negative*." In addition, student 11 also said that the bulb would not light up because "*both positive and negative should be connected or wired.*"

Meanwhile, in item 10, student 7 agreed that the circuit would light up because of the presence of "*different charges*." Asked about these different charges, he claimed that they came from the connection in the positive and negative terminal. He also added that the wire should be connected to these terminals to interact between the positive and negative charges for the bulb to turn on. Moreover, student 9 said that the bulb would light up because of positive and negative charges when the bulb is connected to the battery's terminals. He further claimed that if the connection is only on the positive terminal, the bulb "*will not light because it is not balanced*." These responses show that students believe that current has something to do with the interaction of positive and negative charges.

Science Teachers' Common Misconceptions

Table 7 shows the misconception scores and the percentages of the participating science teachers.

Table 7. Science Teachers' Misconceptions About Electricity.

Model of Misconception	Score	Percentage (%)
Short circuit	2.7	33.4
Current flow as water flow	2.3	29.1
Clashing current	2.0	25.0
Shared current	2.0	25.0
Local reasoning	1.3	16.6
Parallel circuit	1.0	12.5
Empirical rule	0.3	4.1
Attenuation	0.0	0.0
Sequential reasoning	0.0	0.0
Sink	0.0	0.0
Power supply as a constant current source	0.0	0.0

The findings show that the most common misconception of teachers about electricity is under the short circuit model. It means that the most prevalent misconception of the participating teachers is the belief that if there is a branch of a circuit where there is no load connected, this branch can be ignored as if it does not influence the other branches of the circuit (Chambers & Andre, 1997; Fredette & Clement, 1981; Sencar & Eryilmaz, 2004; as mentioned in Pesman & Eryilmaz, 2009). It is contrary to the proper conception that the presence of a branch in a circuit where there is no load connected in it has a great effect on the circuit. Most of the current will flow to the said branch because it offers little resistance to current. This phenomenon is called a short circuit.

Other prevalent misconceptions of science teachers about electricity include those under the current flow as water flow, clashing current, and shared current. They recorded percentages greater than 20.0%. Other recorded misconception models observed among teachers are the local reasoning, parallel circuit, and empirical rule models. The other four models were not recorded to be possessed by teachers since none of them gave answers constituting these models.

These results of the science teachers are very comparable to the results of the students. The students and teachers share common misconceptions with five models (clashing current, shared current, water flow as current flow, short circuit, local reasoning) recorded in both groups. In contrast, only one model in each group (empirical rule for students and parallel circuit for teachers) is not observed in the other group.

These findings are comparable to the results of the study of Onder et al. (2017). In their study, 69% of the participating preservice teachers have some misconceptions about short circuits. Meanwhile, 22% of them have misconceptions about open circuits.

On the other hand, these results are different from the findings of the study of Cibik (2016) on science teacher candidates. The findings of this study showed that the participants' common misconceptions are that current is formed due to the presence of a voltage in a circuit, that energy moves electrons in a circuit, that power influences electrons, and that a source like a generator produces current.

On the other hand, Table 8 shows the number of science teachers giving a "not sure" response to the third tier of the test items in the SECDT. Their responses can be interpreted as a lack of knowledge of the questions. This result shows their lack of confidence in their answers. This is similar to the students' responses.

Table 8. Rate of Lack of Knowledge of Science Teachers in the SECDT Items.

Item – Topic Asked	Number of "Not Sure"Responses	Percentage (%)
1 – How to construct a circuit	0	0.0
2 – Current in a parallel circuit	3	37.5
3 – Current in a series circuit	3	37.5
4 – Current in a series circuit	2	25.0
5 – Total resistance in a circuit	3	37.5
6 – Current in a parallel circuit	2	25.0
7 – Current in a parallel circuit	3	37.5
8 – Short circuit	3	37.5
9 – Total resistance in a circuit	4	50.0
10 – How to construct a circuit/short circuit	2	25.0
11 – Current in a parallel	5	62.5
12 – Short circuit	3	37.5

The table shows a high rate of lack of knowledge for all items except for the first item, where all teachers answered that they are sure with their responses in the said item. Items 9 (50.0%) and 11 (62.5%) are the items with the greatest number of "not sure" responses in the third tier. These items also recorded a high occurrence of the same phenomenon with the responses of students. The high occurrence of lack of knowledge among teachers can support that the percentages of misconception models are not that high. Like the participating students, the teachers can be described more as not being too confident of their knowledge of electric circuits rather than being confident about it but having misconceptions.

Meanwhile, the data show a high misconception score for teachers in the short circuit model. They also recorded high rates of lack of knowledge on items about the short circuit. It can be interpreted that most teachers do not have the right conception about short circuits. Most of them either are not well versed in this topic or have a misconception about it.

The results for science teachers can cause alarm since it is expected that they possess a mastery of the content they are teaching to teach science satisfactorily (Orbe et al., 2018). With the findings showing that the teachers themselves have misconceptions about electricity that are comparable to what students have while at the same time having a lack of knowledge of some electrical concepts, a need for revisiting science teachers' knowledge of basic electrical concepts is raised. These findings can be due to the transition of the science curriculum under the K-to-12 program from a compartmentalized style to a spiral progression style of teaching science concepts (Orbe et al., 2018). These resulted in physics majors teaching nonphysics topics while at the same time nonphysics majors teach physics concepts. In their study of K–12 chemistry teachers, Orbe et al. (2018)

suggested that science teachers who teach not their area of specialization need to educate and update themselves on the teaching concepts to deliver satisfactory chemistry teaching performance. Since only one of the eight participating teachers is a physics major, the teachers can look at this suggestion to address their misconceptions and knowledge of basic electrical concepts.

While the study showed that students and science teachers share common misconceptions about electricity, it is unclear if the teachers contributed to students' misconceptions. A need for a more comprehensive study is required to determine if this claim can be valid.

CONCLUSION

The study showed that the most common misconception of students about electricity is the clashing current model. This model states that a device connected in a circuit runs because a battery supplies negative and positive electricity and their clashing causes it to run. Other common misconceptions of students about electricity are under the short circuit, empirical rule, shared current, local reasoning, and current flow as water flow models. Aside from this, many students manifested a lack of knowledge in some of the items in the SECDT.

Meanwhile, science teachers' most common misconception is under the short circuit model. This model says that if a branch in a circuit has no loads connected to it, it can be disregarded as it does not affect the rest of the circuit. Other observed misconception models among teachers are under the local reasoning, parallel circuit, and empirical rule models. Moreover, teachers also manifested a lack of knowledge of some of the items in the SECDT.

There are similarities in the misconceptions the students and the science teachers have about electricity. These include the misconceptions under the clashing current, shared current, water flow as current flow, short circuit, and local reasoning models. Meanwhile, only one model for each group (empirical rule for students and parallel circuit for teachers) is not common in the other group.

To address students' misconceptions and their lack of knowledge of basic electrical concepts, science teachers are advised to adopt different strategies in teaching electricity to their students. These strategies can explore more the misconceptions of the students to correct them. At the same time, these strategies should also seek to improve the overall conceptual understanding of students on these topics.

It is also suggested that teachers seek ways to improve their conceptual knowledge of electricity. This addresses the recorded lack of knowledge and misconceptions through training and other learning endeavors, especially knowing that some teachers who teach electricity are nonphysics majors. In that way, they can help address their students' lack of knowledge and misconceptions about electricity.

More studies that focus on determining if science teachers can transmit their misconceptions to students whenever they teach electricity and how teachers address their content knowledge in electricity can also be performed.

A larger scale study involving more science teachers and students about the same topic can also be done to get more generalized results to devise a much better response in addressing students' and science teachers' misconceptions about electricity. It is also interesting to also determine the rate of correct students' conceptions regarding electricity to understand the situation better. Interviews can also be done with teachers to understand their classroom instructional practices better and explain their rationale for implementing these practices.

The continuous pursuit of improving instruction in physics is very important for it is beneficial to the students, teachers, and all stakeholders. The search to fully understand how students and teachers understand basic concepts in physics, like electricity, is a small yet vital step towards addressing the overall performance of students in physics.

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