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RESEARCH ARTICLE

An In-depth Analysis of Science Teachers' Knowledge, Attitudes, and Skills Towards Cognitive Conflict Strategies, Multiple Representations Model, and Misconception Remediation Strategies in Terms of Demographic Aspects

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ABSTRACT

The purpose of this study is to obtain information about science teachers' knowledge, attitudes, and skills toward Cognitive Conflict (CC), Multiple Representation (MR), and Remediation of Misconception (RM) models or strategies in terms of their demographic aspects. Data was collected using a survey method with high school and junior high school science teachers, employing a 5-point Likert scale questionnaire with 5 items for each variable of the CC, MR, and RM models or strategies. After conducting descriptive statistical analysis using Excel software, it was generally found that science teacher training activities (Information Technology or Pedagogical) contributed to knowledge, attitudes, and skills in the CC, MR, and RM models or strategies. School location and the habit of reading textbooks also contributed to knowledge, attitudes, and skills. However, gender and the subjects taught did not significantly differ in terms of knowledge, attitudes, and skills. Overall, the results showed no significant differences in knowledge, attitudes, and skills concerning the CC, MR, and RM models or strategies when viewed from demographic aspects. Therefore, it is recommended that future research include more question items and involve samples that cover science teachers from elementary, middle, and high schools.

INTRODUCTION

Cognitive conflict, multiple representations, and misconception remediation are models or strategies that are closely related to conceptual understanding in science education. These three models or strategies are key to helping students understand difficult concepts or correct misconceptions in science learning. Cognitive Conflict (CC) is a state of perception where one piece of information does not align with a person's cognitive structure and the environment (external information), or between components of a person's cognitive structure (such as a person's conceptions, beliefs, sub-structures, and so on within the cognitive structure) with information from the student's environment (Abuh, 2021). Another expert defines cognitive conflict as a state where there is a mismatch between the cognitive structure held by a person and the new information received from the outside (Madu, 2017). The cognitive conflict strategy involves (1) identifying concepts that are misunderstood by students, (2) confronting students with contradictory (conflicting) information in the form of experimental facts, real videos, and anomalous or contradictory concepts, (3) asking questions or providing information to create equilibration, (4) evaluating the level of conceptual change between students' initial ideas or beliefs by conducting a posttest after instructional intervention, and (5) reconstructing concepts through the recovery of conceptual knowledge (Hewson & Hewson, 1984; Effendy, 2002; Widia, Suhirman, & Mujitahid, 2022). Learning based on cognitive conflict has a very significant impact or is closely related to conceptual change (Jimoyiannis, 2010; Laughran, 2020; Derry et al., 2020; Azmi, & Festiyed, 2023), and also to misconception remediation (Parwati & Suharta, 2020; Mufit et al., 2020; Dhanil & Mufit, 2021; Akmam, Anshari, Amir, Jalinus, & Amran, 2018, April ; Hasanah & Wasih, 2021).

In addition, Multiple Representation (MR) is defined as the method or form of presenting the same concept in several different formats. Some forms of representation in the field of physics may include word narratives, images, diagrams, graphs, computer simulations, videos, simulations, animations, and visualizations of mathematical equations, among others (Kilpeläinen & Sarjakoski, 2020; Mila, 2018; Hasbullah, Halim, & Yusrizal, 2018). Several previous studies have shown that the MR approach has a very significant impact on reducing misconceptions in science learning (Damsi, & Suyanto, 2023; Apriliani, Erlina, Melati, Sartika, & Lestari, 2022; Busyairi & Zuhdi, 2020; Nurhayati & Natasukma, 2019; Sriyanshah, 2015).

The activity of Remediation of Misconception (RM) or reducing the percentage of students experiencing misconceptions has been carried out in various ways, including using conventional modules (Halim, Subahan, & Lilia, 2008; Sadaghiani, & Pollock, 2015; Halim, Soewarno, Elmi, Zainuddin, Huda, & Irwandi, 2020), interactive multimedia modules (Lee & Osman, 2012; Yang & Lin, 2015), and computer-based simulations model (Islamiyah, Rahayu & Dasna, 2022). Several previous studies related to the development of e-learning modules have been widely conducted, including the development of E-learning modules in the form of virtual lab media using PhET simulations to enhance student motivation (Yusuf & Widyaningsih, 2020), the development of a two-tier E-learning-based evaluation tool for identifying misconceptions (Halim, Mustafa & Lestari, 2018), and the development of a three-tier E-learning-based evaluation tool (Resta, Halim & Huda, 2020). The development of E-learning-based tests is also part of the development of E-learning-based modules.

he process of Remediation of Misconception (RM) on the concept of dynamic electricity using computer simulation media (Halim, Mahzum, Yakob, & Irwandi, 2021), the concept of temperature and heat through laboratory work (Halim et al., 2014b), the concept of quantum with modules (Halim, Subahan, & Lilia, 2008), the concept of quantum with the conceptual change model (Majidy, 2024), the concept of dynamic electricity with computer-based simulation (Islamiyah, Rahayu & Dasna, 2022), and an online inquiry-based learning environment addressing misconceptions on students' performance (Siantuba, Nkhata, & de Jong, 2023). All the types of remediation methods carried out were manual (offline), meaning that students would know the level of remediation success after the results were analyzed by the researchers, which required several days to obtain information about the level of misconception reduction. To address this limitation, several studies have been conducted through the use of web media or e-learning, including for the concept of ecology (Hidayatun, Karyanto, Fatmawati, & Mujiyati, 2015), the concept of motion dynamics (Chen, Bao, Fritchman, & Ma, 2021), and the concepts of the photoelectric effect and electron diffraction (Halim & Nanda, 2018).

Several recent studies relevant to this topic indicate that the application of the CC strategy does not affect attitudes toward mathematics learning (Zetriuslita, Wahyudin, & Dahlan, 2018). The CC strategy can serve as a learning strategy for conceptual change and also influences the learning outcomes of students with strong attitudes (Limón, 2001; Khoeriah, Sunarno, & Pujayanto, 2024). Regarding the MR model, it shows that the skill of using the MR model affects problem-solving abilities in mathematics (Hwang, Chen, Dung, & Yang, 2007). The level of students' skills in using the MR model significantly influences their ability to solve addition, subtraction, and multiplication operations (Kara & Incikabi, 2018). Other results show that students proficient in using the multiple representations model are more creative in mathematics learning compared to control group students who were trained with another model (Bicer, 2021). Based on the analysis of the research results presented in this paragraph, it shows that the CC strategy and MR model play an important role in improving abilities and learning outcomes in the field of science. Therefore, it is crucial to obtain initial data from science teachers (mapping) on attitudes, knowledge, and skills in the CC, MR, and RM models or strategies in science learning.

Research Problem

All the research findings that have been cited or as described in the paragraph above are limited to experiments or research treatments conducted by researchers at the higher education level or from certain research institutions. In fact, the main benefit of studies in this field is not only to observe the impact or achievements on students, but also to ensure that science teachers in secondary schools understand and are capable of using the CC, MR, and RM models or strategies in their daily science teaching activities. To implement these models or strategies effectively, initial data on science teachers' attitudes, knowledge, and skills regarding these models or strategies is necessary.

Research Focus

Through this research, a deep analysis is intended to be conducted regarding the knowledge, skills, and attitudes of science teachers at the secondary school level. The data from this research is very important to serve as a benchmarking tool for decision-making related to the implementation of science teacher training in the future. From data collection techniques on knowledge, attitudes, and skills to training science teachers (in further research) so that they can apply the CC, MR, and RM models or strategies, this research aims to provide valuable insights. The data in this first stage is the result of a thorough analysis of science teachers' abilities, attitudes, and skills regarding the CC, MR, and RM models or strategies, viewed from the demographic aspects of science teachers at the secondary school level.

Research Aim and Research Questions

The main objective of this study is to obtain in-depth data regarding the attitudes, knowledge, and skills of science teachers on the CC, MR, and RM models or strategies, reviewed from the demographic aspects of the participants. Based on this main objective, several research questions are derived, namely:

1. Mapping of knowledge, attitudes, and skills regarding the CC, MR, and RM models or strategies, viewed from the demographic aspects of science teachers (Q1)
2. Analysis of the relationship between the demographic aspects of science teachers and their knowledge about the CC, MR, and RM models or strategies (Q2)
3. Analysis of the relationship between the demographic aspects of science teachers and their attitudes toward the CC, MR, and RM models or strategies (Q3)
4. Analysis of the relationship between the demographic aspects of science teachers and their skills regarding the CC, MR, and RM models or strategies (Q4)
5. Analysis of the relationship between knowledge, attitudes, and skills on the CC, MR, and RM models or strategies, viewed from the demographic aspects of science teachers (Q5)
6. Analysis of the relationship between endogenous variables and exogenous variables (demographic aspects) by adopting the TAM model (Q6).

Research Methodology

General Background

This research is related to the identification of knowledge, attitudes, and skills of science teachers regarding the CC, MR, and RM models or strategies, reviewed from the demographic aspects of the respondents. Efforts to obtain initial data from science teachers (mapping) on attitudes, knowledge, and skills in the CC, MR, and RM models or strategies will greatly assist in the implementation of science teacher training on these three strategies in the future. In line with the research objectives, this study uses a survey research method with secondary school science teachers. The data collection questionnaire was developed by the researcher, referring to several previous studies, including those by Wahono & Chang (2019a), Wahono & Chang (2019b), and Parmin, Saregar, Deta, & El Islami (2020). The data is then analyzed using descriptive statistics and also inferential statistics. Furthermore, the sample, data collection instruments, and data analysis methods will be elaborated in their respective subtopics.

Sample or Research Participants

The main sample involved in this study consists of secondary school science teachers currently teaching science subjects (Biology, Physics, Chemistry, and General Science). The reason for selecting secondary school science teachers as the sample in this study is to train them in the following year, so that science teachers have the knowledge and ability to apply the CC, MR, and RM models or strategies in science teaching. A total of 176 science teachers (N) from various secondary school levels were selected for this study, and are detailed in Table 1.

Table 1: The number of science teachers or samples (N = 176) in terms of various demographic aspects.

Demographics	Sub. Demographics	n
Gender	Male	14
	Female	162
Teaching lessons	Physics	41
	Chemistry	33
	Biology	43
	Science	51
	Sciences-Social	5
IT Training	Often	33
	Rarely	126
	Never	17
Pedagogy Training	Often	36
	Rarely	127
	Never	11
School Location	In-town	87
	Suburb	42
	Village area	46
School Level	High School	105
	Junior High School	69
	Elementary School	1
	Islamic Boarding School	1
Bachelor's Degree Alumni	Syiah Kuala University	66
	State Islamic University	12
	State University of Medan	21
	Others	76
Reading activities	Often	140
	Rarely	32

Demographics	Sub. Demographics	n
	Never	1

The data in Table 1 shows that the sample involved in this study has a fairly diverse demographic aspect, ranging from gender to reading activities aimed at increasing knowledge, especially related to pedagogical knowledge. Based on the demographic variation of the selected sample, an in-depth analysis was conducted to examine the relationship between attitudes, knowledge, and skills in using the CC, MR, and RM models or strategies.

Instrumentation and Data Collection Procedures

The instrument used in this study is a Likert scale questionnaire with 5 points, with 5 items for each variable from the CC, MR, and RM models or strategies, but the content or answer choices correspond to the variables being measured. For example, for measuring Attitudes, the 5-point answer choices are: Strongly Agree (SA), Agree (A), Less Agree (LA), Disagree (D) and Strongly Disagree (SD). For measuring the knowledge variable, the 5-point answer choices also follow these criteria: Very Understand (VU), Understand (U), Less Understand (LU), Do Not Understand (NU) and Very Do Not Understand (VNU). For measuring the skills variable, the answer choices use criteria such as: Very Often (VO), Often (O), Sometimes (S), Never (N), and Very Never (VN). The indicators used for constructing the instrument refer to Wahono & Chang (2019a), Wahono & Chang (2019b), and Parmin, Saregar, Deta, & El Islami (2020). The instrument used in this study, adapted from the three studies, has been validated with a Cronbach's alpha value greater than 0.6.

This study uses a survey method, and there are no specific procedures as typically followed in experimental research. Initially, the school locations where the science teachers work were selected from three clusters (north, central, and southwest) in the Aceh province. Then, based on available finances and time, schools were selected from the northern and central regions of Aceh. There were no specific requirements for the location of the science teacher's school, as long as the science teachers had at least 3 years of teaching experience in Biology, Physics, Chemistry, or General Science. The characteristics of the science teachers involved as samples in this study are shown in Table 1. The researcher and the research team members visited the school locations where the science teachers worked, and after gathering all the science teachers in the surrounding area of each school in every location (district/city), data collection sessions using the questionnaire took about 45 minutes, including explanations of the implementation technique and the process of filling out the questionnaire.

Data Analysis

The purpose of the data analysis and statistical formulas used refer to the research questions as formulated in the introduction section, namely; (Q1) Mapping knowledge, attitudes, and skills related to the CC, MR, and RM models or strategies in terms of the science teachers' demographic aspects, (Q2) Analysis of the relationship between the demographic aspects of science teachers and Knowledge about the CC, MR, and RM models or strategies, (Q3) Analysis of the relationship between the demographic aspects of science teachers and attitudes toward the CC, MR, and RM models or strategies, (Q4) Analysis of the relationship between the demographic aspects of science teachers and skills regarding the CC, MR, and RM models or strategies, (Q5) Analysis of the relationship between Knowledge, attitudes, and skills in the CC, MR, and RM models or strategies in terms of the science teachers' demographic aspects, and (Q6) Analysis of the relationship between endogenous and exogenous variables (demographic aspects) by adopting the TAM model.

Based on these research questions, two types of data analysis are needed; namely, descriptive statistical analysis and inferential statistical analysis. For the answer to research question Q1 (mapping), descriptive statistical analysis is required (percentage calculation, mean, standard deviation, etc.), while the answers to research questions Q2–Q5 (relationships and contributions) require inferential analysis results (correlation and factor contribution). As for the answer to research question Q6 (also using correlation and contribution equations), the TAM model diagram is used for development to view the holistic relationship between endogenous and exogenous variables.

Research Results

In accordance with the research questions as formulated in the introduction section, the results of the study reported in this section include (1) The results of mapping knowledge, attitudes, and skills related to the CC, MR, and RM models or strategies in terms of the science teachers' demographic aspects, (2) The results of the analysis of the relationship between the demographic aspects of science teachers and knowledge about the CC, MR, and RM models or strategies, (3) The results of the analysis of the relationship between the demographic aspects of science teachers and attitudes toward the CC, MR, and RM models or strategies, (4) The results of the analysis of the relationship between the demographic aspects of science teachers and skills regarding the CC, MR, and RM models or strategies, (5) The results of the analysis of the relationship between knowledge, attitudes, and skills in the CC, MR, and RM models or strategies in terms of the science teachers' demographic aspects, and (6) The results of the analysis of the relationship between endogenous and exogenous variables (demographic aspects) by adopting the TAM model.

Mapping of Attitudes, Knowledge, and Skills toward Demography (Q1)

In this section, two categories of results are presented: (a) Mapping of attitudes, knowledge, and skills based on descriptive statistical variables, and (b) Mapping of attitudes, knowledge, and skills based on the demographic aspects of science teachers. The data in Table 2 represents the mapping results of the descriptive statistical analysis of knowledge, attitudes, and skills in the CC, MR, and RM models or strategies. Based on the data in Table 2, it can be seen that the average skill level of science teachers is very low (3.43) in using these models or strategies. This indicates that high school science teachers rarely use the CC, MR, and RM models or strategies in science teaching.

Table 2: Descriptive data on knowledge, attitudes, and skills of science teachers using CC, MR, and RM models or strategies.

	Knowledge				**Attitude**				**Skills**				**Means**
Stat. Variables	CC	MR	MR	Means	CC	MR	MR	Means	CC	MR	MR	Means	**Total**
Means	4,10	4,20	3,80	4,03	4,10	4,30	4,30	4,23	3,30	3,50	3,50	3,43	3,90
Max.	4,40	4,80	4,80	4,53	5,00	5,00	5,00	5,00	4,60	4,60	5,00	4,35	4,33
Min.	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,18
Standard Deviation	0,68	0,74	0,79	0,67	0,79	0,78	0,76	0,75	1,07	1,04	1,06	0,97	0,66
Corr.item-subtotal	0,90	0,92	0,89	1,00	0,95	0,97	0,97	1,00	0,89	0,94	0,91	1,00	1,00
R^2	0,81	0,85	0,80	1,00	0,90	0,94	0,94	1,00	0,79	0,89	0,83	1,00	1,00
Corr.subtotal-total				0,85				0,80				0,85	1,00
R^2				0,73				0,64				0,73	1,00

The mapping of science teachers' attitudes, knowledge, and skills towards the CC, MR, and RM models or strategies, based on demographic aspects, is shown in tables 3a-3c. The data in Table 3a shows that the science teachers' knowledge of the CC, MR, and RM models or strategies, based on demographic aspects, falls within the category of 3-4 (Less Understanding-Understanding). There is no significant difference in terms of gender, with an average total of approximately 3.10 for males and 3.11 for females. The training aspect significantly affects teachers' knowledge, both in IT training and Pedagogical Training. Science teachers who frequently attend IT training (3.32) or Pedagogical Training (3.33) have deeper knowledge in the field of CC, MR, and RM models compared to teachers who have never attended IT training (3.00) or pedagogical training (3.04).

Table 3a: Descriptive statistical variable values of knowledge towards CC, MR, and RM models or strategies, in terms of the demographic aspect

Demographics	Sub. Demographics	(n)	Means (Knowledge)			Means	SDV
			CC	MR	MR	total	(Knowledge)
Gender	Male	14	3,10	3,09	3,14	3,10	0,554
	Female	162	3,13	3,18	3,25	3,11	0,711
Teaching lessons	Physics	41	3,05	3,15	3,29	3,02	0,674
	Chemistry	33	3,14	3,26	3,28	3,14	0,618
	Biology	43	3,20	3,11	3,28	3,77	1,060
	Science	51	3,11	3,15	3,18	3,10	0,671
	Sciences-Social	5	3,24	3,40	3,28	3,24	0,388
IT Training	Often	33	3,32	3,41	3,30	3,32	0,595
	Rarely	126	3,09	3,12	3,22	3,07	0,701
	Never	17	3,08	3,11	3,29	3,00	0,751
Pedagogy Training	Often	36	3,33	3,45	3,39	3,33	0,831
	Rarely	127	3,06	3,07	3,18	3,06	0,630
	Never	11	3,16	3,27	3,44	3,04	0,808
School Location	In-town	87	3,08	3,14	3,21	3,08	0,697
	Suburb	42	3,29	3,25	3,27	3,29	0,515
	Village area	46	3,07	3,14	3,27	3,04	0,779
School Level	High School	105	3,14	3,23	3,34	3,94	0,814
	Junior High School	69	3,11	3,07	3,11	3,10	0,716
	Elementary School	1	3,60	4,00	4,00	3,60	0
	Dayah/Pesantren	1	3,00	3,00	1,00	0,00	0
Bachelor's Degree Alumni	USK	66	3,14	3,29	3,29	3,12	0,743
	UIN Ar-Raniry	12	3,07	3,12	3,15	3,13	0,735
	Unimed	21	3,03	3,05	3,45	3,03	0,523
	Others	76	3,16	3,11	3,16	3,14	0,690
Reading activities	Often	140	3,24	3,26	3,31	3,21	0,683
	Rarely	32	2,71	2,79	3,01	2,70	0,629
	Never	1	2,60	2,60	1,80	2,60	0

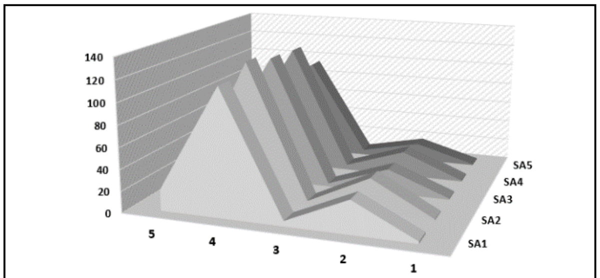
The data in Table 3b provides an overview of science teachers' attitudes towards the CC, MR, and RM models or strategies, based on demographic aspects, with an overall average ranging from 3.00 to 4.00 (Disagree-Agree). This suggests that science teachers have a neutral attitude, neither rejecting nor fully accepting these models or strategies. For example, the distribution of responses or answers from science teachers on the attitude test towards the CC strategy is shown in Figure 1. In general, the highest percentage of responses from science teachers for each item is in the "4" or "Agree" category, followed by "2" or "Disagree." Furthermore, based on the data in Table 3b, it can also be seen that science teachers who frequently participate in pedagogical training show a significant impact on their attitudes towards the CC, MR, and RM models or strategies, with an average response of 4 or "Agree" from 36 out of 176 science teachers.

Table 3b: Descriptive statistical variable data of attitudes towards CC, MR, and RM models or strategies, in terms of the demographic aspect

Demographics	Sub. Demographics	(n)	Means (Attitude)			Means	SDV
			CC	MR	MR	total	(Attitude)
Gender	Male	14	3,83	4,03	4,20	3,83	1,017
	Female	162	3,83	3,89	3,92	3,79	0,870
Teaching lessons	Physics	41	3,85	3,87	3,95	3,79	0,897
	Chemistry	33	3,98	4,08	4,05	3,98	0,648
	Biology	43	3,86	3,93	3,98	3,77	1,060
	Science	51	3,64	3,73	3,78	3,64	0,840
	Sciences-Social	5	4,16	4,20	4,20	4,16	0,427
IT Training	Often	33	4,08	4,11	4,10	4,08	0,694
	Rarely	126	3,80	3,86	3,92	3,76	0,892
	Never	17	3,53	3,76	3,79	3,53	0,910
Pedagogy Training	Often	36	4,00	4,07	4,06	4,00	0,808
	Rarely	127	3,79	3,86	3,92	3,76	0,896
	Never	11	3,67	3,71	3,84	3,67	0,837
School Location	In-town	87	3,70	3,81	3,85	3,71	0,891
	Suburb	42	3,91	3,94	3,97	3,85	0,829
	Village area	46	3,98	3,99	4,07	3,90	0,880
School Level	High School	105	3,96	4,01	4,05	3,94	0,814
	Junior High School	69	3,61	3,70	3,76	3,59	0,933

Demographics	Sub. Demographics	(n)	Means (Attitude)			Means	SDV
			CC	MR	MR	total	(Attitude)
	Elementary School	1	4,60	5,00	5,00	4,60	0
	Dayah/Pesantren	1	4,00	4,00	4,00	0,00	0
Bachelor's Degree Alumni	USK	66	3,88	3,95	3,99	3,88	0,743
	UIN Ar-Raniry	12	3,77	3,83	3,87	3,93	0,750
	Unimed	21	3,78	4,00	4,05	3,78	0,763
	Others	76	3,80	3,82	3,88	3,72	1,005
Reading activities	Often	140	3,87	3,95	3,96	3,83	0,887
	Rarely	32	3,66	3,68	3,83	3,72	0,853
	Never	1	4,40	4,20	5,00	4,40	0

The same applies to science teachers who frequently participate in IT training, with an average response of 4 or "Agree" from 33 out of 176 science teachers. Based on both sets of data, it can be said that IT and pedagogical training activities attended by science teachers have a positive impact on their attitudes towards the CC strategy, MR model, and RM strategy.



	5	4	3	2	1
SA1	20	118	5	31	2
SA2	11	128	4	32	1
SA3	28	121	3	23	1
SA4	27	119	5	24	1
SA5	59	94	5	17	1

Figure 1: Percentage distribution of respondents' answers regarding attitudes toward CC strategy

Meanwhile, the attitude data from the demographic aspect of school level for the sub-answer choices "Elementary School," "Dayah/Pesantren," and the attitude data from the aspect of reading activities for the sub-answer choice "Never" are in the category between "Agree" and "Strongly Agree," but the number of respondents is only 1. Statistically, such a small number of respondents is not representative and does not reflect the overall responses provided.

The data in Table 3c relates to the skills of science teachers in using the CC, MR, and RM models or strategies, reviewed from demographic aspects. According to the information in Table 3c, there are

9 demographic aspects considered in this study, including gender, teaching lessons, IT training, pedagogy training, school location, and others. Based on the three components of Bloom's taxonomy (Knowledge, Attitudes, and Skills), the skills component is very low, with the lowest response variation ranging from 1.99 to 2.87, or in the category of "Very Rarely" to "Never." This indicates that most teachers never use the models or strategies used in this study.

Table 3c: Descriptive statistical variable values of skills against CC, MR, and RM models or strategies, in terms of the demographic aspect

Demographics	Sub. Demographics	(n)	Means (Skill)			Means total	SDV (Skill)
			CC	MR	MR		
Gender	Male	14	1,99	2,34	2,23	1,99	1,041
	Female	162	2,68	2,81	2,72	2,67	1,062
Teaching lessons	Physics	41	2,63	2,87	2,73	2,60	1,082
	Chemistry	33	2,84	2,65	2,55	2,84	0,923
	Biology	43	2,54	2,69	2,62	2,54	1,112
	Science	51	2,52	2,79	2,75	2,52	1,143
	Sciences-Social	5	2,68	3,04	2,88	2,68	0,882
IT Training	Often	33	2,87	3,07	2,82	2,87	1,046
	Rarely	126	2,53	2,68	2,63	2,52	1,109
	Never	17	2,81	2,86	2,78	2,81	1,030
Pedagogy Training	Often	36	2,53	2,88	2,76	2,53	1,243
	Rarely	127	2,62	2,73	2,61	2,62	1,100
	Never	11	2,84	3,02	3,15	2,84	0,996
School Location	In-town	87	2,71	2,84	2,78	2,71	1,058
	Suburb	42	2,44	2,65	2,50	2,40	1,136
	Village area	46	2,60	2,74	2,64	2,59	1,024
School Level	High School	105	2,64	2,76	2,66	2,62	1,038
	Junior High School	69	2,61	2,78	2,68	2,62	1,116
	Elementary School	1	1,00	2,60	4,60	1,00	0

Demographics	Sub. Demographics	(n)	Means (Skill)			Means total	SDV (Skill)
			CC	MR	MR		
	Dayah/Pesantren	1	3,00	3,00	3,00	0,00	0
Bachelor's Degree Alumni	USK	66	2,62	2,90	2,73	2,62	1,073
	UIN Ar-Raniry	12	2,67	2,50	2,33	2,82	1,152
	Unimed	21	2,55	2,67	2,59	2,55	0,813
	Others	76	2,63	2,74	2,71	2,61	1,114
Reading activities	Often	140	2,70	2,84	2,74	2,69	1,077
	Rarely	32	2,39	2,54	2,45	2,39	0,951
	Never	1	1,00	1,00	1,00	1,00	0

In addition, from the demographic aspect, the skills of science teachers in using the CC, MR, and RM models or strategies vary. For example, male science teachers rarely (1.99) use the CC strategy in science teaching. On the other hand, male science teachers who frequently participate in IT training showed skills in using the MR model, which falls under the "sometimes" category (3.04).

The relationship between demographic aspects and science teacher knowledge (Q2)

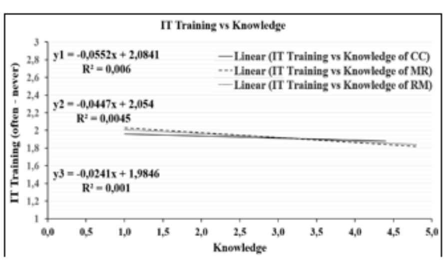
In this section, several data analysis results are presented regarding the relationship between the demographic aspects of science teachers and their knowledge of the CC, MR, and RM models or strategies. The demographic aspects analyzed about the respondents' activities include (a) IT training, (b) Pedagogical training, (c) School location, and (d) Textbook reading activities. All of these analysis results are presented in graphical form through Figures 2, 3, 4, and 5. The graph in Figure 2 provides information about the relationship between IT training and respondents' knowledge of the CC, MR, and RM models or strategies.

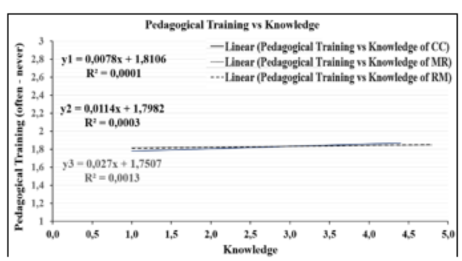
Figure 2.

The relationship between IT training and knowledge in CC, MR, and RM science teachers

Figure 3.

The relationship between pedagogical training and knowledge in CC, MR, and RM of science teachers.





Based on the data in the graph in Figure 2, it shows that an increase in the frequency of IT training activities leads to an improvement in knowledge of the CC, MR, and RM models or strategies. The data also indicates that the greatest impact of IT training is on knowledge of the CC strategy, followed by the RM strategy, with the lowest impact being on knowledge of the MR model.

Next, the graph in Figure 3 provides information about the relationship between Pedagogical training and science teachers' knowledge of the CC, MR, and RM models or strategies. Based on the data in the graph in Figure 3, it shows that an increase in the frequency of pedagogical training activities leads to a decrease in knowledge of the CC, MR, and RM models or strategies. The data also indicates that the greatest impact of pedagogical training is the decrease in knowledge of the CC strategy, followed by the decrease in knowledge of the MR model, with the lowest impact being on the decrease in knowledge of the RM strategy.

Figure 4.

The Relationship between school location and knowledge CC, MR, and RM of science teachers

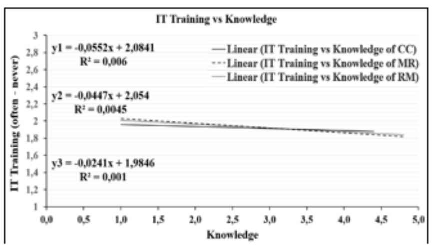
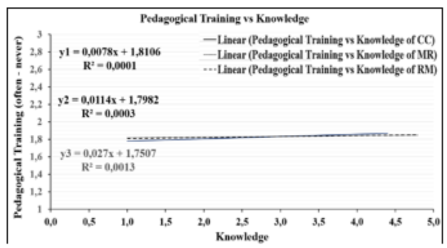


Figure 5.

The relationship between reading activity and science teachers' knowledge CC, MR, and RM



Next, the graph in Figure 4 provides information about the relationship between the location of the school where science teachers teach and their knowledge of the CC, MR, and RM models or strategies. Based on the data in the graph in Figure 4, shows that the location of the school where science teachers teach has a significant impact on their knowledge of the CC, MR, and RM models or strategies. The data also indicates that the greatest impact of the school location is on the improvement of knowledge of the CC strategy, followed by the improvement in knowledge of the MR model, and the lowest impact is on the improvement in knowledge of the RM strategy. In other words, the shift or relocation of the school from a rural area to an urban area will significantly enhance science teachers' knowledge of the CC, MR, and RM models or strategies.

Next, the graph in Figure 5 provides information about the relationship between science teachers' textbook reading activities and their knowledge of the CC, MR, and RM models or strategies. Based on the data in the graph in Figure 5, shows that the frequency of science teachers' textbook reading activities (from frequent to never) has a significant impact on their knowledge of the CC, MR, and RM models or strategies. The data also indicates that the greatest impact of the habit of reading textbooks is on the improvement of knowledge in the CC strategy, followed by the improvement in knowledge of the MR model, and the lowest impact is on the improvement of knowledge in the RM strategy. In other words, an increase in science teachers' textbook reading activities will significantly enhance their knowledge of the CC, MR, and RM models or strategies.

The relationship between demographic aspects and science teacher attitudes (Q3)

In this section, several results of data analysis will be presented regarding the relationship between the demographic aspects of science teachers and their attitudes toward the CC, MR, and RM models or strategies. The demographic aspects analyzed about respondents' activities include (a) IT training, (b) Pedagogical training, (c) School location, and (d) Textbook reading activities. All of these analysis results are presented in the form of graphs through Figures 6, 7, 8, and 9. The graph in Figure 6 provides information about the relationship between IT training and respondents' attitudes toward the CC, MR, and RM models or strategies.

Figure 6.

The relationship between IT training and science teachers' attitudes towards CC, MR, and RM.

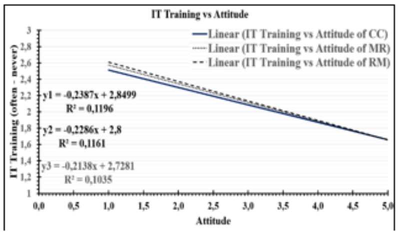
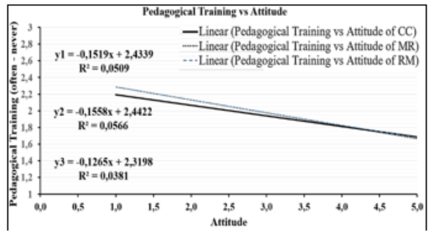


Figure 7.

The Relationship between pedagogical training and science teachers' attitudes in CC, MR, and RM.



Overall, it shows that science teachers' attitudes toward the CC, MR, and RM models or strategies are relatively strong and positive. Although the line displayed has a negative slope, the correlation between them holds a positive meaning. This is because the scale used for demographic aspects (1 to 3) differs from the scale used in attitude measurement (5 to 1). In other words, a decrease in the y-axis value indicates that IT training activities are conducted more frequently, which in turn positively impacts science teachers' attitudes toward the CC, MR, and RM models or strategies. The same results also apply to pedagogy training; an increase in pedagogy training activities will improve science teachers' attitudes toward the CC, MR, and RM models or strategies.

Figure 8.

The relationship between school location and science teachers' attitudes toward CC, MR, and RM

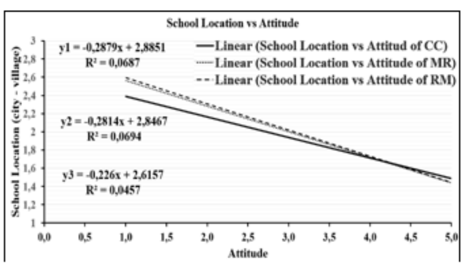
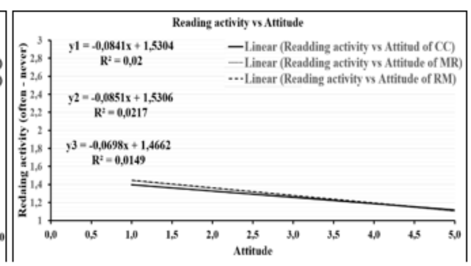


Figure 9.

The relationship between reading activity and science teachers' attitudes toward CC, MR, and RM.



Meanwhile, the information in Figures 8 and 9 indicates that school location and science teachers' textbook reading habits have a positive impact on their attitudes toward the CC, MR, and RM models or strategies. For example, science teachers teaching in urban areas exhibit more positive attitudes than those teaching in rural schools. Among the three models or strategies, the positive attitude of science teachers toward the CC strategy is significantly more influenced by the school location where they teach. Furthermore, an increase in science teachers' textbook reading habits also significantly affects their attitudes toward the CC, MR, and RM models or strategies. Science teachers who frequently read textbooks exhibit more positive attitudes toward the CC, MR, and RM models or strategies compared to those who rarely read textbooks.

The relationship between demographic aspects and science teachers' skills (Q4)

This section presents several data analysis results regarding the relationship between science teachers' demographic aspects and their skills in using the CC, MR, and RM models or strategies. The demographic aspects analyzed are related to respondents' activities, including (a) IT training, (b) pedagogical training, (c) school location, and (d) textbook reading activities. All the analysis results are presented in graphical form through Figures 10, 11, 12, and 13. The graph in Figure 10 provides information about the relationship between IT training and respondents' skills in using the CC, MR, and RM models or strategies.

Figure 10.

The relationship between IT training and science teachers' skills in using CC, MR, and RM.

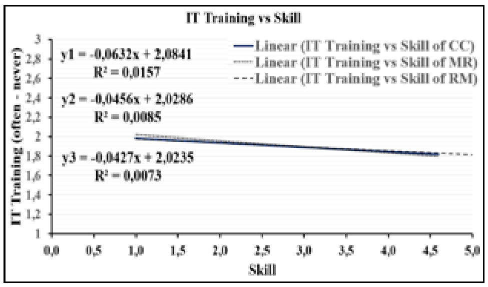
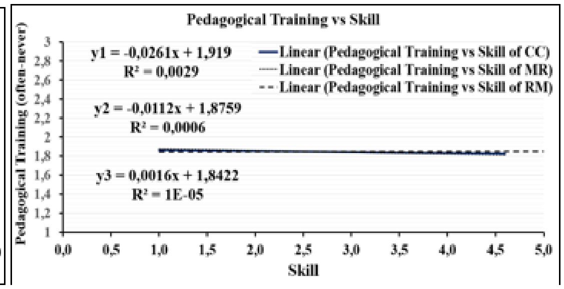


Figure 11.

The relationship between pedagogical training and science teachers' skills in using CC, MR, and RM.



The data in Figures 10 and 11 provide information about the relationship between IT training and pedagogical training and science teachers' skills in using the CC, MR, and RM models or strategies. Both graphs in these figures reveal the same phenomenon, with a slope of approximately 0.01–0.0021. This indicates that the teachers' skills in using the CC, MR, and RM models or strategies fall into the categories of 'Rarely' and 'Never.' In other words, there is almost no correlation between IT and pedagogical training activities and science teachers' skills in using the CC, MR, and RM models or strategies.

Furthermore, Figures 12 and 13 provide information about the relationship between school location and science teachers' reading activities with their skills in using the CC, MR, and RM models or strategies in science teaching. Overall, both graphs convey the same information: school location and textbook reading habits have a small but positive effect (with a very slight slope) on skills in using the CC, MR, and RM models or strategies in science teaching. This indicates that science teachers teaching in urban schools are more skilled in using the CC, MR, and RM models or strategies compared to those teaching in rural schools. The same applies to textbook reading habits: science teachers who frequently read textbooks are more skilled in using the CC, MR, and RM models or strategies in science teaching.

Figure 12.

The relationship between school location and science teachers' skills in using CC, MR, and RM.

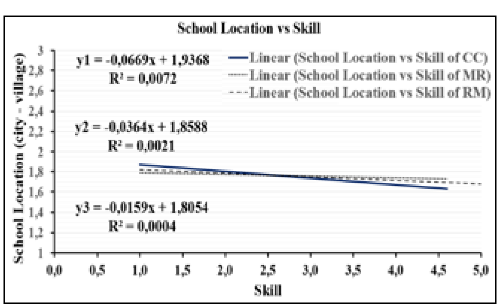
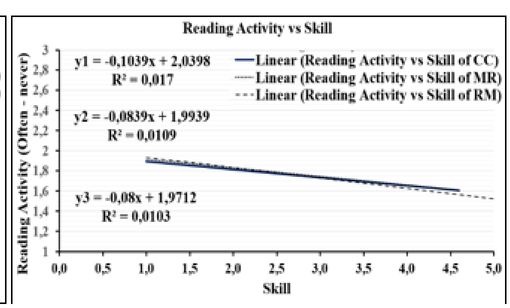


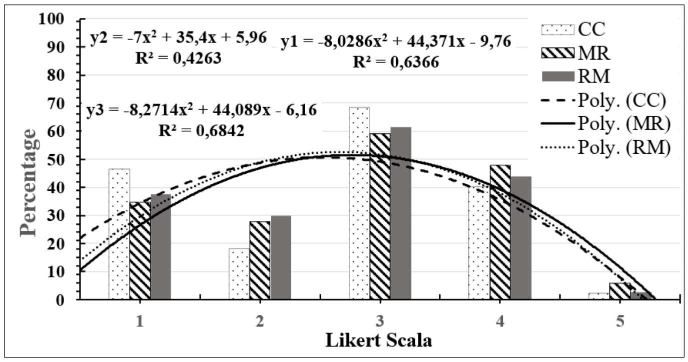
Figure 13.

The relationship between reading activity and science teachers' skills in using CC, MR, and RM



However, there is other, more interesting information than that finding. The measurement of science teachers' skills in this study used a questionnaire with a 5-point Likert scale, with answer choices following this pattern: (5 = Very Often, 4 = Often, 3 = Rarely, 2 = Never, 1 = Very Never). This means that science teachers who never use these models or strategies would choose answers 2 and 1, corresponding to the categories 'Never' and 'Very Never.'

Figure 14.The distribution of science teachers' answer choices for skills in using the CC, MR, and RM models or strategies.



Based on the graph in Figure 14, it shows that the distribution of answers chosen by science teachers ranges from 5 to 1, with the following details: 5.63% of respondents chose 1 (Very Never), 3.59% chose 2 (Never), 8.95% chose 3 (Rarely), 6.25% chose 4 (Often), and 0.52% chose 5. The comparison of science teachers' skills in using the three models shows that overall, the responses tend to fall under 'Rarely' and 'Never'.

The relationship between knowledge, attitudes, and skills in using CC, MR, and RM (Q5)

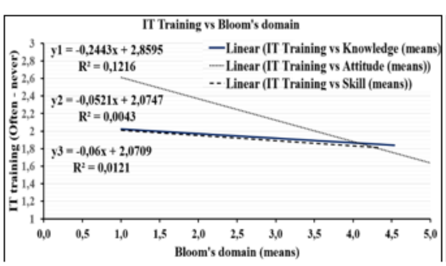
This section presents several data analysis results regarding the relationship between knowledge, attitudes, and science teachers' skills in using the CC, MR, and RM models or strategies, reviewed from the demographic aspects of science teachers. The purpose of the data analysis in this section is to understand how the average knowledge, attitudes, and skills of science teachers toward the CC, MR, and RM models or strategies are influenced by the following aspects: (a) IT training, (b) pedagogical training, (c) school location, and (d) textbook reading activities. All the analysis results are presented in graphical form through Figures 15, 16, 17, and 18. The graph in Figure 15 provides information about the relationship between knowledge, attitudes, and average skills toward the CC, MR, and RM models or strategies, reviewed from the aspect of IT training activities attended by science teachers.

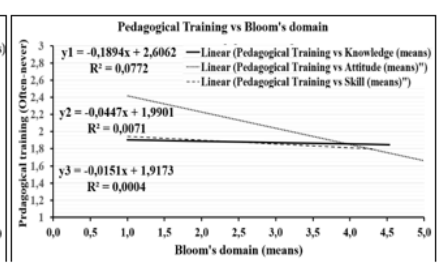
Figure 15.

The relationship between the average knowledge, attitudes, and skills in using CC, MR, and RM, was reviewed from IT training.

Figure 16.

The relationship between the average knowledge, attitudes, and skills in using CC, MR, and RM, reviewed from pedagogical training





Meanwhile, the graph in Figure 16 provides information about the relationship between the average knowledge, attitudes, and science teachers' skills in using the CC, MR, and RM models or strategies, reviewed from the aspect of pedagogical training activities attended by science teachers. Overall, the response patterns provided by science teachers are relatively similar, with the highest slope found in attitudes and the smallest slope in knowledge regarding these models or strategies. This indicates that science teachers who frequently attend IT or pedagogical training tend to have a positive attitude toward the models or strategies examined (shown) in this study.

Figure 17.

The relationship between the average knowledge, attitudes, and skills in using CC, MR, and RM, reviewed from school location.

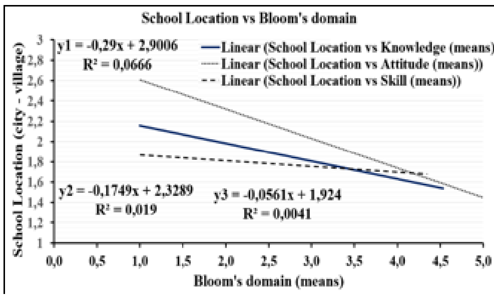
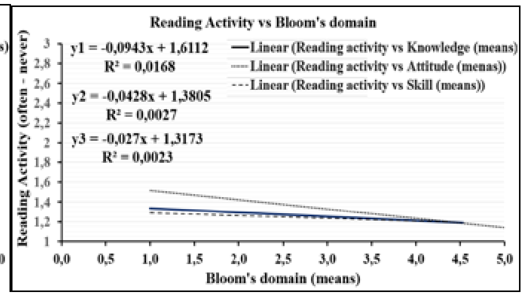


Figure 18.

The relationship between the average knowledge, attitudes, and skills in using CC, MR, and RM, reviewed from reading activity



Furthermore, the graphs in Figures 17 and 18 provide information about the relationship between science teachers' knowledge, attitudes, and skills in using the CC, MR, and RM models or strategies, reviewed from school location and science teachers' textbook reading habits. The information in Figure 17 shows that the steepest slope is found in attitudes, followed by knowledge, and lastly skills, with significant differences. Meanwhile, the information in Figure 18 reveals a similar trend, but the differences among the three lines are not as significant. This indicates that school location and science teachers' textbook reading habits have a positive impact on their attitudes, knowledge, and skills. In other words, science teachers teaching in urban areas exhibit a more positive attitude toward the models or strategies presented in this study.

The relationship between endogenous and exogenous variables by adopting the TAM model(Q6).

This section presents several data analysis results regarding the relationship between endogenous variables (knowledge, attitudes, and skills) and exogenous variables (demographic aspects) of science teachers, based on measurements from the CC, MR, and RM models or strategies. This data analysis aims to understand the holistic relationship between endogenous variables (knowledge, attitudes, and skills) and exogenous variables (demographic aspects) along with measurement data from the CC, MR, and RM models or strategies.

The demographic aspects reviewed in this analysis include:

(a) IT training,

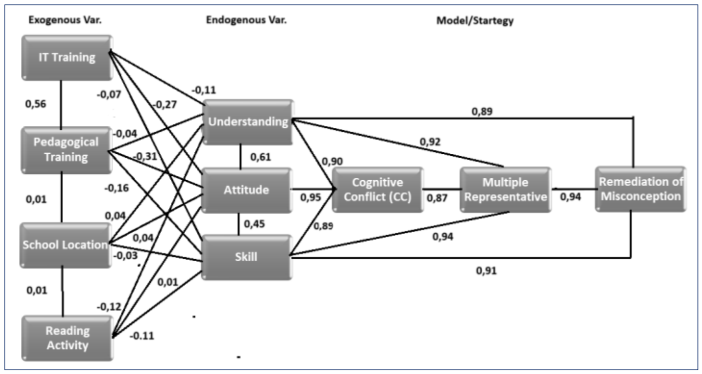
(b) pedagogical training,

(c) school location, and

(d) textbook reading activities.

All analysis results are presented in the form of a TAM (Technology Acceptance Model) diagram in Figure 18. The selection of the TAM model in this analysis is based on several recent research findings. Some modifications have been made, showing that the components in the TAM model have been separated into endogenous and exogenous variables (Putri, Widagdo, & Setiawan, 2023; Mayasari, Febriantoko, Putra, Hadiwijaya & Kurniawan, 2023; Wiryawan & Nugroho, 2023; Yanto, Kabatiah, Zaswita & Candra, 2023; Fahmiyah, Utami, Ningrum, Fakhruzzaman, Pratama & Triangga, 2023)).

Figure 19. The relationship between endogenous and exogenous variables based on CC, MR, and RM data by adopting the TAM model.



Based on the data analysis results shown in Figure 19, several key findings can be identified: Each model or strategy (CC, MR, and RM) has a strong and positive correlation and provides significant contributions to the average measurements of knowledge, attitudes, and skills. The three domains of Bloom's taxonomy (knowledge, attitudes, and skills) have strong and positive correlations.

Overall, the correlation between endogenous and exogenous variables is weak and negative. Both training activities (IT and Pedagogy) have strong and positive correlations. From these four findings, the most intriguing is the negative correlation between endogenous and exogenous variables.

All items within the demographic aspects of exogenous variables have negative scales or range from small to large. For example, the IT training aspect has response options: 1 = Often, 2 = Rarely, and 3 = Never. Similarly, for the demographic aspect of school location, the response options are: 1 = Urban, 2 = Suburban, and 3 = Rural. Meanwhile, the response options for measuring endogenous variables are on a positive scale, ranging from large to small. For example, the item "The CC strategy is useful for improving students' conceptual knowledge" has response options: 5 = Strongly Agree, 4 = Agree, 3 = Unsure, 2 = Disagree, and 1 = Strongly Disagree. This discrepancy is what causes the negative correlation between endogenous and exogenous variables, and it provides a significant meaning to their relationship.

For example, the negative correlation between IT training and knowledge, attitudes, and skills can be interpreted as an increase in IT training activities leading to improvements in knowledge, attitudes, and skills (this fact is also supported by the data in Figures 2, 6, 10, and 14). The same conclusion applies to pedagogical training activities. Meanwhile, the location of the school where science teachers teach does not significantly correlate with knowledge, attitudes, and skills.

DISCUSSION

This section provides a more in-depth discussion of the data analysis results presented in the previous research findings section. The structure or order of the discussion remains aligned with the research questions formulated in the introduction and the findings already presented. Each discussion outlined in this section is supported by references to relevant research conducted by previous researchers in the same field.

Mapping of Attitudes, Knowledge, and Skills toward demography (Q1)

The mapping results of attitudes, knowledge, and skills toward the CC, MR, and RM models or strategies, as shown in Table 2, indicate that science teachers' attitudes received the highest responses, while skills had the lowest, and responses toward knowledge were relatively moderate. These responses varied somewhat when linked to demographic aspects. For instance, male science teachers exhibited lower responses in terms of skills compared to female science teachers. Previous relevant studies also indicate that responses are influenced by the respondent's gender. For example, research conducted by Algara, Fuller, Hare, and Kazemian (2021) showed that knowledge is significantly related to gender. Moreover, confidence and aspirations in science learning are significantly influenced by gender (Kang, Keinonen, & Salonen, 2021). Other studies have revealed significant differences in the improvement of critical thinking skills between male and female students. For instance, male students tend to have faster responses and higher confidence compared to female students when solving problems (Ramdani, Jufri, Gunawan, Fahrurrozi, & Yustiqyar, 2021).

In addition, this study also examined the effects of demographic aspects (IT or pedagogical training) on knowledge, attitudes, and skills, as shown in Tables 3a, 3b, and 3c. Overall, across these three tables, the effects of training (IT or pedagogical) showed no differences except for the attitude component, which displayed a variation. In other words, science teachers who frequently participated in training (IT or pedagogical) exhibited more positive attitudes toward the CC, MR, and RM models or strategies. Several previous relevant studies have shown similar findings. For example, respondents who received training exhibited more positive attitudes and improved concentration (Sharma & Nuktal, 2016). Another study indicated that training positively impacts motivation and work outcomes (Mangkunegara & Agustine, 2016).

The Relationship Between Demographic Aspects and Science Teachers' Knowledge (Q2)

The demographic aspects focused on include IT training, pedagogical training, school location, and teachers' habits of reading textbooks. These four demographic aspects are linked to science teachers' knowledge of the CC, MR, and RM models or strategies.

The data analysis results show that an increase in the frequency of IT training activities leads to an improvement in knowledge of the CC, MR, and RM models or strategies. The data also indicates that the largest impact of IT training activities is on knowledge of the CC strategy, followed by the RM strategy, and the smallest impact is on knowledge of the MR model. Several previous studies have also shown that IT training improves the efficiency and effectiveness of management system knowledge (Tseng, 2008). Other research findings indicate that technology training increases employees' or farmers' knowledge and leads to an increase in participants' per capita income (Mehra, Langer, Bapna, & Gopal, 2014; Hussain, Byerlee, & Heisey, 1994).

Furthermore, the graph in Figure 3 provides information about the relationship between pedagogical training and science teachers' knowledge of the CC, MR, and RM models or strategies. According to the data in the graph in Figure 3, an increase in the frequency of pedagogical training activities results in a decrease in knowledge of the CC, MR, and RM models or strategies. The data also shows that the largest impact of pedagogical training activities is on the decrease in knowledge of the CC strategy, followed by the MR model, and the smallest impact is on the RM strategy.

This finding seems generally contrary to the objectives of pedagogy itself, which aim to enhance participants' understanding and knowledge. Several previous studies indicate that the effects of pedagogical training influence the measurement scale of conceptual change approaches and self-efficacy beliefs. Even when the effects of teaching experience are controlled to identify the unique influence of pedagogical training, the results remain consistent. Interviews with participants also revealed that there were positive effects of pedagogical training on their teaching practices (Postareff, Lindblom-Ylänne, & Nevgi, 2007). However, other previous research also found that training has a negative impact on pedagogical knowledge and a positive impact on skills. This is because the training materials did not align with the teachers' learning needs (Ningtiyas, 2018, September)).

The relationship between demographic aspects and science teacher attitudes (Q3)

The demographic aspects focused on include IT training, pedagogical training, school location, and teachers' habits of reading textbooks. These four demographic aspects are linked to science teachers' attitudes toward the CC, MR, and RM models or strategies.

The data in Figures 6, 7, 8, and 9 illustrate science teachers' attitudes toward the CC, MR, and RM models or strategies based on IT training, pedagogical training, school location, and textbook-reading habits. Based on these four demographic aspects, it can generally be understood that IT training, pedagogical training, school location, and teachers' habits of reading textbooks positively influence science teachers' attitudes toward the CC, MR, and RM models or strategies.

For example, IT training has a very positive influence on science teachers' attitudes. In other words, science teachers who frequently participate in IT training have more positive attitudes toward the CC, MR, and RM models or strategies. Most teachers, both from special and regular education, show more positive attitudes toward inclusion after training compared to before (Proedrou, Stankova, Malagkoniari, & Mihova, 2023).

The aspect of school location shows that science teachers teaching in urban and suburban areas have more positive attitudes toward the CC, MR, and RM models or strategies compared to science teachers teaching in rural areas. Relevant research also finds that the physical environment of schools (e.g., school location) affects teachers' attitudes, which in turn impacts their productivity (Earthman & Lemasters, 2009). Other research findings indicate that teachers' experiences of teaching and living in rural areas lead to significant attitude changes toward teaching in rural regions and help eliminate misconceptions about life and teaching in rural areas (Hudson & Hudson, 2008).

The relationship between demographic aspects and science teachers' skills (Q4)

The data analysis results, presented in graphs in Figures 10, 11, 12, and 13, indicate that demographic aspects such as IT training, pedagogical training, school location, and textbook-reading habits influence science teachers' attitudes toward the CC, MR, and RM models or strategies. Demographic aspects with relatively greater impact include IT training, school location, and textbook-reading habits, while pedagogical training has almost no effect on science teachers' skills in using the CC, MR, and RM models or strategies.

Several previous studies also demonstrate that certain demographic aspects influence science teachers' skills in implementing models or strategies. For instance, teachers who participate in training experience positive impacts on their skills and on their students as well (Gibbs & Coffey, 2004). Similarly, teachers who undergo pedagogical training become more skilled in communication, whether they teach technology subjects or science subjects (Popescu-Mitroi, Todorescu, & Greculescu, 2015). At a teacher education institution in Portugal, it was found that professional development for teachers is most effectively carried out through pedagogical training (Fernandes, Araujo, Miguel & Abelha, 2023).

In addition, science teachers' skills in using models or strategies differ between CC, MR, and RM, although the differences are not significant, as shown in Figure 14. The downward-opening parabola graph ($a < 0$) in Figure 14 indicates that the tendency (maximum peak) of science teachers' skills in using the CC model leans toward "Rarely" or "Never" compared to the MR model and RM strategy, which tend more (maximum peak) toward "Often" and "Very Often."

Several previous findings also reveal that the application of the cognitive conflict (CC) strategy in problem-based learning has a greater impact on critical thinking skills than on communication skills or curiosity (Zetriuslita, Wahyudin, & Dahlan, 2018). Regarding the relationship between attitudes (skills) and the multiple representation (MR) model, it has been shown that implementing the MR model does not significantly influence attitude development in mathematics subjects (Çıkla, 2004).

Regarding science teachers' knowledge of the term "misconception remediation," some science teachers in Punjab, Pakistan, were found to lack knowledge about misconceptions and techniques for addressing them (Anam, 2018). Based on these findings and this study's results, it is recommended that training on the three models or strategies CC, MR, and RM be conducted as an essential activity in science education curriculum development..

The relationship between knowledge, attitudes, and skills in using CC, MR, and RM (Q5)

The data analysis results, shown in Figures 15, 16, 17, and 18, indicate that among Bloom's three domains—Knowledge, Attitude, and Skills—the attitude domain differs from the knowledge and skills domains. For example, the impact of training (IT or Pedagogical) on science teachers' attitudes toward the CC, MR, and RM models or strategies is highly significant. Similarly, the impact of school location and textbook-reading activities on science teachers' attitudes toward the CC, MR, and RM models or strategies is much higher compared to the knowledge and skills domains.

These findings indicate that, overall, the demographic aspects of science teachers influence their attitudes toward the CC, MR, and RM models or strategies. However, some studies suggest that the relationship between school location and teachers' or students' attitudes does not differ significantly. For example, there is no significant difference in attitudes between teachers or students from urban and rural schools in Calabar, Nigeria (Ntibi & Edoho, 2017).

The findings in Calabar differ from this study's results, where school location significantly influences science teachers' attitudes, as shown in Figure 17. One reason is that school locations in Aceh province differ between urban and rural areas in terms of both geography and community attitudes toward education. In other words, science teachers teaching in rural schools are influenced by the customs and traditions of the local community, leading to teachers' attitudes being shaped by the attitudes of the surrounding community. This finding is supported by research conducted by education experts in Nigeria, which indicates that the everyday phenomena surrounding schools affect science teachers' attitudes and experiences in implementing teaching practices (Ogunleye & Fasakin, 2011).

The relationship between endogenous and exogenous variables by adopting the TAM model (Q6).

This section accommodates all analysis results of variables, demographic aspects, and Bloom's taxonomy domains into a single diagram, adopted from the Technology Acceptance Model (TAM) (Figure 19). The primary purpose of this in-depth analysis is to holistically examine the interconnections of all measurable components in this study. The data in Figure 19 are divided into three main parts: exogenous variables, endogenous variables, and models/strategies.

The exogenous variables in this study refer to demographic aspects external to the participants, such as training, school location, and others. The endogenous variables include all aspects inherent to the participants, such as attitudes, knowledge, and skills. Meanwhile, the CC, MR, and RM models or strategies are the objects targeted for data collection.

Based on the relationships (correlations and contributions) among all measured components, the findings are as follows:

(a) The exogenous variable of IT training shows a strong positive correlation with pedagogical training but a weak positive correlation with school location and textbook-reading activities.

(b) All exogenous variables have a weak negative correlation with endogenous variables.

(c) The endogenous variables (knowledge, attitude, and skills) show strong positive correlations with one another.

(d) The models or strategies (CC, MR, and RM) exhibit very strong positive correlations with one another.

(e) The correlations between the endogenous variables and the CC, MR, and RM models or strategies are also very strong and positive.

Based on theoretical concepts, the content of IT training does not differ significantly from pedagogical training. A study conducted on 271 in-service teachers shows that IT training positively impacts teachers, and there is a positive correlation between self-efficacy and teachers' professional development (Paraskeva, Psycharis, & Papagianni, 2007).

The scale for exogenous variables (IT and pedagogical training, school location, and textbook-reading activities) ranges from 1 (high) to 3 (low). For example, IT training response options are 1 (Often), 2 (Rarely), and 3 (Never). The design of this response scale results in a negative correlation with endogenous variables. However, the interpretation remains positive—for instance, an increase in IT training frequency from "Never" to "Often" positively impacts attitudes toward each measured model or strategy. The same applies to other exogenous variables (pedagogical training, school location, and textbook-reading activities).

Furthermore, Bloom's taxonomy domains are also influenced by other demographic aspects, such as educational level, gender, and teaching experience. Relevant studies suggest that male students are significantly better in terms of skills and self-confidence compared to female students (Logan & Medford, 2011). Research also indicates that gender differences affect motor skills and physical activity. Higher motor skills improve outdoor play activities only among male participants (Samara, Sidharta, Mediana, & Noviyanti, 2012).

Bloom's taxonomy domain (endogenous variable) overall has a high and positive correlation, with a significant contribution to the CC, MR, and RM models or strategies. In other words, the measurement of knowledge demonstrates a high contribution (81%) to the average value of the Cognitive Conflict strategy. Meanwhile, knowledge measurement results contribute significantly to the MR model and RM strategy, at 85% and 80%, respectively. The measurements of attitude and skills also show similar contributions, ranging from 80% to 90%. This indicates that Bloom's taxonomy domain has a close relationship with the Cognitive Conflict strategy, Multiple Representation model, and Misconception Remediation strategy..

CONCLUSIONS AND IMPLICATIONS

Overall, the findings indicate that science teachers possess knowledge and attitudes about the CC, MR, and RM models or strategies. However, their skills in applying these models or strategies are largely infrequent, with some never utilizing them at all. Science teachers who frequently participate in IT or pedagogical training tend to have a more positive attitude toward all types of these models or strategies. Data analysis shows that the greatest impact of pedagogical training activities is a decrease in knowledge of the CC strategy, followed by a decrease in knowledge of the MR model, and the smallest decrease is in knowledge of the RM strategy. This finding seems generally contrary to the purpose of pedagogy itself, which is to enhance participants' understanding and knowledge. Previous research has also shown that the effects of pedagogical training influence the measurement scale of conceptual change approaches and self-efficacy beliefs.

The demographic aspect of the school location (where science teachers teach) shows that science teachers in urban and suburban areas have a more positive attitude toward the CC, MR, and RM models or strategies compared to those teaching in rural areas. Relevant studies also reveal that the physical environment of schools (location, etc.) affects teachers' attitudes, which in turn influences their productivity. Another study indicates that the experience of teaching and living in rural areas significantly changes teachers' attitudes toward teaching in rural areas and reduces misconceptions about rural life and teaching. Another finding shows that science teachers' skills in applying the models or strategies differ among CC, MR, and RM, although the differences are not very significant. Based on data analysis in the form of a downward-open parabolic graph, it is evident that the tendency (maximum peak) of science teachers' skills in using the CC model leans toward "Rarely" or "Never," compared to the MR model and RM strategy, which tend to lean toward "Often" and "Very Often."

Additionally, the impact of school location and the activity of reading textbooks is very significant on science teachers' attitudes toward the CC, MR, and RM models or strategies, compared to the domains of knowledge and skills. This finding indicates that overall, the demographic aspects of science teachers influence their attitudes toward the CC, MR, and RM models or strategies. The findings in this study remain preliminary (average values) from a descriptive statistical perspective. This is because the items for each CC, MR, and RM model or strategy are still minimal (only five items per domain). Therefore, future research should increase the number of question items for each domain of Bloom's taxonomy for the identified models or strategies..

Authors' Contributions

Each author contributed to the preparation of this article, including: the first author, AH, contributed to drafting the article; the second author, IK, contributed to data input in Excel and data analyisis; EV contributed to writing the introduction; MY contributed to the literature review; and NM contributed to the research methodology.

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