Identification of Chemistry Learning Before, During, and After the Pandemic

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Abstract
This study aims to answer how the impact of the pandemi on learning outcomes, IT mastery, material mastery and teacher creativity in chemistry lessons before, during and after the Covid 19 pandemi. Researchers used a qualitative approach with a field research design or grounded theory design by applying a descriptive method. Methods of data collection is done by conducting questionnaires, interviews and using a list of values. Questionnaire result data were analyzed descriptively using frequency tables. These results are used as a reference in collecting data through interviews. Interviews were carried out repeatedly until data saturation was obtained. The results of the interview transcripts were then analyzed using open coding and taking notes. Open coding results are grouped according to category. The categories obtained are then compared to look for relationships between categories. This was also carried out by re-checking the results of the questionnaire and list of values in order to obtain results that corroborate previous research. The results of the study corroborate Christensen's theory of disruptive innovation where to overcome disruption in chemistry learning, teachers and students take action by increasing mastery of information technology, teachers also increase creativity in learning chemistry. The creativity of teachers in chemistry learning includes making learning videos (equalizing reaction equations, chemical stoichiometry, nomenclature of hydrocarbon compounds, geometric isomers), practical video tutorials (identification of acids and bases, buffer solutions, hydrolysis of salts), using flasher applications (titrations, thermochemistry, flames, voltaic cells), as well as utilizing materials at home such as materials for making isomers using plasticine, identifying acids-bases with natural indicators, making batteries using fruits, metal plating using bathroom cleaners. In line with Piaget's constructivism learning theory that the procedural dimension is more meaningful if it is done by doing practicum compared to watching videos. After the pandemic, the video was needed to help students make it easier to understand procedures when practicing in the laboratory. Chemistry understanding in conceptual and procedural dimensions during online learning has decreased.
Keywords: the impact of the pandemic, learning, chemistry, learning outcomes, mastery of technology, teacher creativity
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A. INTRODUCTION

The ability of a nation to become prosperous, intelligent and competitive in the midst of globalization issues and to excel in mastering technological innovation rests on the quality of its human resources. For this reason, quality education is needed by the Indonesian people. "Recover Together, Recover Stronger" is the theme raised at the G20 Summit in Bali 15-16 November 2022. One of the contents of the Bali leaders' declaration is to rebuild an education system that is resilient, technologically capable, easily accessible and effective because education is a human right and important tool for economic recovery.

Early 2020 was a tough day for the world. It began with an outbreak of the corona virus in Wuhan, China in December 2019 which spread throughout the world so quickly that on January 30, 2020 WHO declared it an International Public Health Emergency, "Public Health Emergency of International Concern" and declared a pandemic condition on March 11, 2020 The government calls for social distancing

This social restriction was followed up by the Minister of Education and Culture of the Republic of Indonesia (Mendikbud RI) by issuing Circular (SE) No. 4 of 2020 on March 24, 2020 which regulates the Implementation of Education Policies in the Emergency Period of the Spread of Corona Virus Disease (COVID-19). One of the contents of the SE is that the process of learning from home is carried out through distance learning, or better known as online (in the network).

This situation changes the habits of human life, including in the world of education, which is known as entering the "New Normal" order. Face-to-face learning becomes learning activities at home or known as "Distance Learning" (PJJ) or online. Distance learning activities and assignments can vary between students according to the interests and conditions of each student, including considering the gap in access or study facilities at home.

The efforts of the government and the people of Indonesia in order to return online learning to face-to-face learning are carried out by implementing 5M discipline (washing hands, wearing masks, keeping distance,

staying away from crowds and reducing mobility) and accelerating vaccinations. Starting January 2022, East Java, which is included in a level 3 area with 50% of educators and educational staff having carried out vaccinations, can conduct limited face-to-face learning. Furthermore, based on the Instruction of the Minister of Home Affairs (Inmendagri) Number 20 of 2022 which took effect on April 5, 2022, East Java began to experience an increase, which was originally at levels 3 and 4 to levels 1, 2 and 3. Arrangements for Face-to-Face Learning in districts / city that is at level 1-2 with the 2nd vaccination dose Educators and Education Personnel (PTK) more than 80% carry out full Face-to-Face Learning (PTM) with a maximum duration of 6 hours in one day. Regencies/cities that are at level 1-2 with the total dose of the 2nd PTK vaccination less than 80%, PTM is carried out with 50% student attendance. In districts/cities that are at level 3 PTM is carried out through full distance learning (PJJ), or better known as online (in the network).

Starting in early March 2020, learning in Jombang is simultaneously carried out using an online learning model. Both students, teachers and policy makers in Jombang must fight together against this change, both in terms of IT mastery, technological and psychological facilities and infrastructure to deal with this change. With increasing awareness of implementing health protocols and community demands, on August 9 2020, the Governor of East Java issued an official memorandum for implementing limited learning trials. Jombang began implementing limited learning starting November 1 2020. However, at the end of December 2020, an increase in COVID-19 cases increased, so distance learning was resumed. The decline in COVID-19 cases in mid-2021 caused the East Java Provincial Education Office to adopt a policy of implementing face-to-face learning again, limited to 50%. The declining pandemic conditions prompted the government to issue Minister of Home Affairs No. 20 of 2022 where face-to-face learning is implemented 100%. Evaluation of learning during online learning is carried out online or based on computers and smartphones and is done in their respective homes. Evaluation of 50% of face-to-face learning is carried out based on computers and smartphones and is carried out in schools, while evaluation of 100% of learning is carried out on a paper basis. Class of 2020 students or students who are currently at level XII, experience full online learning at the beginning of the semester to be precise from July to October 2020 and January 2021 to September 2021. 50% PTM learning in mid-semester 3 to be exact from November 1 to December 20 and November to December 2021 and face-to-face learning 100% starting January 10 2022 with a maximum face-to-face duration limit of 6 hours at school in semester 4 and learning returns to normal in semester 5 and 6. Changes in the implementation of the learning process due to the pandemic have had both negative and positive impacts on students and teachers, especially in carrying out the learning process. Online learning encourages teachers to be creative in using technology in the learning process, especially in chemistry subjects.

Chemistry is part of the Natural Sciences where Chemistry is a theoretical and practical study of the interactions, structures and properties of various materials. Chemistry has two elements which include (1) understanding of chemistry and (2) process skills. Understanding of chemistry includes all the material studied. Process skills cover the entire scientific process from observing to communicating research results. In general, the chemistry subject consists of four dimensions of knowledge, namely (1) factual and (2) conceptual knowledge, which are part of understanding chemistry and (3) procedural and (4) metacognitive, which are part of the process skill elements. Chemistry consists of concepts, theories, laws, and principles that are developed based on experiments and research (Wu 2001) and define many theories and concepts that explain how changes in a substance occur. Chemistry learning in schools emphasizes learning chemical concepts in a coherent, structured and detailed manner. Concepts presented in a coherent, structured and detailed manner make it easier for students to understand concepts.

Some of the obstacles in learning chemistry are difficulties in understanding the concepts as a whole, lack of mastery of mathematical calculations, lack of concentration and motivation (Sokrat, et al. 2014), and students do not experience the learning process directly (Chandrasegarana, Treagust and Mocerino 2007). The characteristics of chemistry learning have material in a coherent, structured, detailed and tiered sequence, with difficulties in mastering concepts, it will make it difficult for students to master the next material. This raises misconceptions. With the pandemic, strategies are needed to help students master chemistry concept

Developing conceptual knowledge cannot be separated from developing procedural skills in the chemistry learning process. Research conducted by Ng, et al. 2021 in Malaysia from primary education to university using a mixed method of collecting qualitative data in the form of document analysis from 2010 to 2021, interviews, observations, and open responses as well as quantitative data originating from a survey questionnaire on "Scientific Skills, Human Life Processes, and Properties of Materials" it was concluded that students' knowledge of conceptual and procedural skills can be increased through the implementation of various project-based programs that are integrated with technology. A hybrid approach between in-person and online learning is used as a substitute for traditional methods during a pandemic (Ng, et al. 2021)

Ash, et al. 2022 conducted research on the practicality and effectiveness of case study-based modules in chemical thermodynamics courses (ideal and real gases) as a learning tool during the COVID-19 pandemic. The Chemical Thermodynamics course includes mastery of the concepts of the main principles of thermodynamics

and the ability to solve scientific and technological problems. The case study-based module has proven to be able to help students understand the concept of thermodynamics, be able to use learning resources based on information and communication technology, and be able to make decisions based on the relationship between concepts and laboratory activities (Asih, et al. 2022).

Ramdani.et.al conducted research at one of the universities in Mataram. Ramdani. e.al. innovate by developing a Moodle-based learning management system (LMS) to improve the quality of learning in research methodology courses. The results showed that the LMS Media developed was valid and feasible to use, it could increase students' creativity where verbal and procedural students' scientific creativity increased with high criteria, while the increase in figurative and numerical creativity had medium criteria. (Ramdani, et al. 2021) Research conducted by Arias in Venezuela by conducting virtual tutor Formación (Virtual Teacher Training) and Estrategias Didácticas de Trabajo en Moodle (Moodle Teaching Strategies) shows that student-centered learning strategies contribute to knowledge construction. (Arias 2012)

The results of research conducted by Shidiq.et.al on 55 chemistry teachers from West Java by providing online questionnaires via Google forms containing 10 open questions about chemistry learning and practicum conducted by teachers, show that chemistry teachers have tried to utilize various technological platforms in conducting learning. Most of them have difficulty organizing practicum activities and do nothing. Some teachers try to find practicum multimedia, but this multimedia cannot improve students' processing skills (Shidiq, et al. 2020). Chans. et al. adapting the chemistry laboratory class to online mode, where students carry out practicums at home using materials around them by utilizing virtual space applications in real-time. During the lesson, the teacher briefly explains the procedure and supervises student performance. Students are separated in a virtual space where each team does practicum in real-time, so students can ask for advice anytime when they encounter difficulties. If there are problems with internet connection or insufficient materials, it is enough for one team to carry out the experiment while other classmates participate by giving instructions, recording measurements, and writing observations. Students are given one week to prepare reports and teachers can assess concept understanding by analyzing work and providing feedback. Chans, et al. 2022 Palacio, et.al did the development pre-laboratory video in the form of visual performance accompanied by audio explanation to strengthen the steps of practicum. Palacio, et.al researched the effect of watching pre-laboratory video to students' skill. The understanding of practical concepts was enabled by giving electronic questionnaire of pre-laboratory e-quiz. The results of the research denoted that the activity of video watching and answering e-quiz before practicum can increase students' skill significantly. (Palacio, et al. 2022).

In line with Palacio, Chan, et.al conducted a literature study on the use of virtual laboratories. The results of this study indicate that virtual laboratories are more effective than passive teaching methods (eg lectures, texts and videos), but have the same or greater effectiveness than live laboratories. The best results are shown when the virtual laboratory is combined with traditional funeral methods. Virtual laboratories can be used as an effective complementary tool or alternative to real live laboratories (Chans, et al. 2022)

Universities with technological support and technology-savvy resources such as the National University of Chimborazo use PhET simulators and virtual laboratories: Crocodile Chemistry 605 and Yenka in order to cope with practicum in laboratories during the COVID-19 pandemic. A study of 102 students from the National University of Chimborazo, Faculty of Human Education Science and Technology, Experimental Science Pedagogy, Chemistry and Biology showed that the PhET simulators and virtual laboratories: Crocodile Chemistry 605 and Yenka enabled feedback and motivation in any guided virtual experiment activities; there is no significant difference in the academic achievement of students, the majority of which achieve learning outcomes (Urquizo, Sánchez and Orrego 2022).

Danila and Agustini conducted research on Grade 2 IPA 2 students at SMAN 1 Driyorejo for the 2020/2021 academic year with the aim of analyzing students' metacognitive abilities using the guided inquiry model on reaction rate material based on online learning. This study used a quantitative descriptive method with a One-Group Pretest-Posttest Design and data collection techniques using tests and questionnaires. The results showed that there was an increase in the metacognitive abilities of students who used the guided inquiry model on the material for reaction rate based on online learning. This shows that learning using the guided inquiry model had a significant effect on students' metacognitive abilities in the material for reaction rate based on online learning (Danila and Agustini 2021). Motivation can also improve student learning outcomes.

The success of online learning also depends on teacher performance. Therefore, Technological, Pedagogical, Content Knowledge (TPACK), and teachers' attitudes towards conducting online distance learning are very important. Research on 109 teachers in Java, Indonesia using a purposed-design survey method using an online questionnaire based on teachers' responses to online distance learning during the COVID-19 pandemic shows that teachers are trying to adapt their teaching and assessment methods by using various technology platforms for distance learning. away online. Teachers' attitudes and TPACK tended to be positive in response to online distance learning although some senior teachers had a negative inclination on aspects of attitude and technology knowledge. It can be interpreted that training in the use of various technologies, and improving the TPACK

skills of chemistry teachers are needed to produce better online distance learning. It is hoped that these results will provide an overview of the challenges and opportunities of online distance learning in chemistry during or after the COVID-19 outbreak (Kartimi, Gloria and Anugrah 2021)

How does the pandemic affect the chemistry learning process in Jombang Regency. What is the impact of the COVID 19 pandemic on student learning outcomes and how was the creativity of chemistry teachers during the COVID 19 pandemic to develop students' factual, conceptual, procedural and metacognitive dimensions? Based on the description above, the researcher wants to conduct research with the title "Identification of Learning in Chemistry Subjects Before, During and After the Pandemi"

B. Research Method

In this study, researchers used a qualitative approach with a field research design or grounded theory design (the preparation of the theory from the basis) with a descriptive method. In this study, researchers observe or participate in social behavior and try to understand this behavior.

The stages of the research method include data collection or data collection, open coding or open coding, axial coding or axial coding and selective coding or selective coding (Creswell 2012). The development research design used can be seen in Figure 2.1
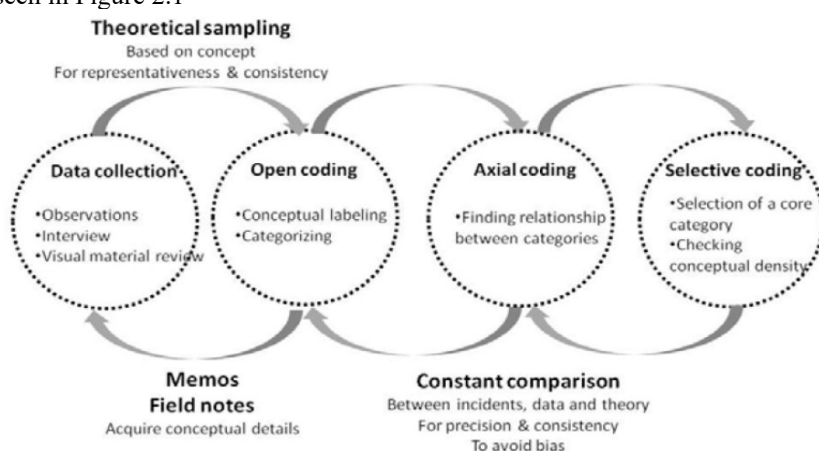

Figure 2.1 Grounded Theory Design

The sequence of data analysis as depicted in Figure 2.1 starts with collecting data and then coding according to category. After finding related keywords, categories are generated. Related categories will generate concepts. The next stage is to select the main concept according to the problem under study to solve the problem, through sample reduction, study the literature that supports the main concept, and select it so as to form a concept that is selected as the core variable to support the theory that will be produced.

Respondents in this study were class XII students at SMAN 1 Jombang for the 2022-2023 academic year and chemistry teachers at SMAN 1 Jombang. The research was conducted at schools where researchers worked every day to make it easier to obtain information and to understand the phenomena and conditions of students in depth. The research was carried out for one year from June 2022 to May 2023. Field data notes or conditions during interviews were used to support the data. Researchers must be open to the changes obtained during the interview. Initially we select students with high academic ability. Based on suggestions from teachers and academic grades as well as the results of questionnaires with open questions, we selected one child each from 4 science classes at SMAN 1 Jombang and 1 student from SMA PGRI 1 Jombang as a semi-structured interview resource.

Data analysis used in this research is descriptive analysis. The data obtained from the questionnaires were analyzed descriptively using a frequency table. From the results of the questionnaire, the selection of informants for interviews was carried out. After collecting interview data, data transcripts and coding were carried out to reflect on the relationship between categories. The results of the relationship reflection allowed us to revise the interview guidelines as a basis for selecting the next informant. Data retrieval was carried out until saturated data was obtained, namely data that had been no new information as part of the confirmation to get a concept or theory.
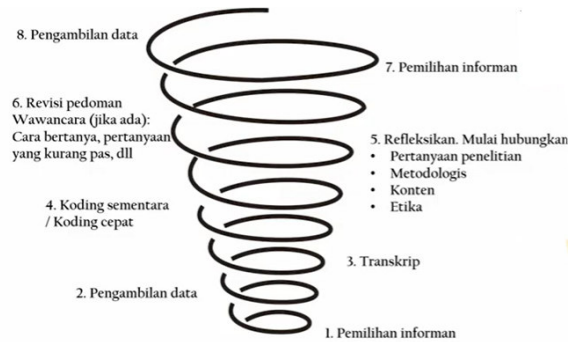
Figure 2.2 Image of Spiraling Data Process

C. FINDINGS AND DISCUSSION
3.1. Questionnaire descriptive analysis

The descriptive analysis of the questionnaire was used as field notes as well as consideration for determining participants. Field notes in this case are condition categories, symptom categories, context categories, intervention categories, action categories, consequence categories for further checking of the data through in-depth interviews with both students and teachers. The condition category is any event that causes a symptom where in this study the cause was the COVID-19 pandemic. The symptom category is the central event that will set in motion a series of actions or interactions. In this study the central event is online chemistry learning. The context category is a complex condition in the form of a specific location or time where an action or interaction takes place. In this research, the context is SMAN 1 Jombang and SMA PGRI 1 Jombang as well as during and after the pandemic. The category of interveners is a structural condition that facilitates or complicates the process in a given context. From the results of the questionnaire the intervening conditions here are government policies, school policies and parents' conditions. The category of action or interaction is a strategy of action taken to respond to or overcome existing problems. Consequence categories are the results obtained because of actions or interactions. In general, these things can be seen from the results of the descriptive analysis of the questionnaire below.

At the start of the pandemic, most students felt confused and did not understand chemistry lessons. This is because most students have not mastered the applications used in learning chemistry.
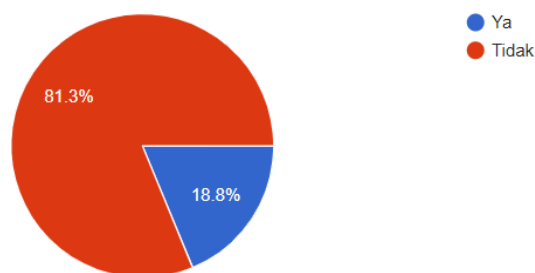

Figure 3.1 Diagram of Ability to Master IT Before the Pandemic

The actions that students take to overcome the inability to master the application are by learning directly from the application, through YouTube tutorials or surfing in cyberspace.

Even so, they try to attend on time and know the online learning schedule. If unable to attend the lesson, students will ask permission from the teacher concerned.
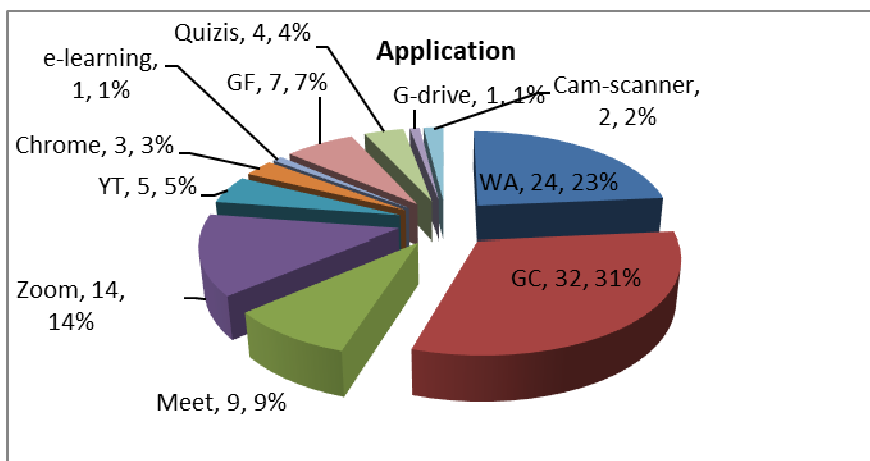
Figure 3.2 Application Used in Online Learning

The applications most often used in chemistry learning at SMAN 1 Jombang are GC, then WA and zoom.

The next symptom is that 51% of students prefer learning media in the form of learning videos both made by teachers and from YouTube.

15. Media komunikasi apakah yang menurut Anda nyaman digunakan pada pembelajaran daring
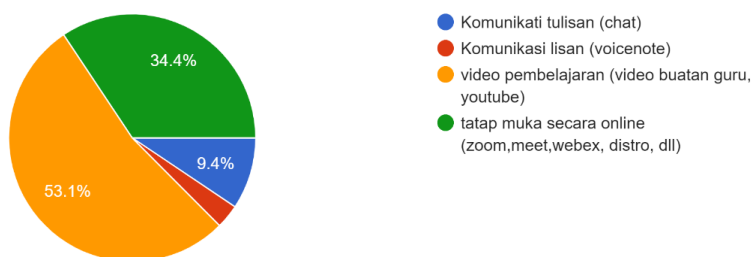32 responses

Figure 3.3 Diagram of Communication Media that Students Prefer in Online Learning

With learning videos they can repeat if they don't understand. Students prefer face-to-face learning online compared to communication through writing or voicenotes because chats in the form of writing or voicenotes will be buried in other chats. In addition, by face-to-face through the zoom application, meet, etc. students can ask questions directly and get answers or explanations when there is material that has not been mastered or is not sufficiently mastered. However, learning using meet/zoom consumes internet quota. One hundred percent agree that the internet greatly influences the learning process while online.

10. Apakah bantuan kuota dari pemerintah sangat membantu Anda dalam pembelajaran daring?
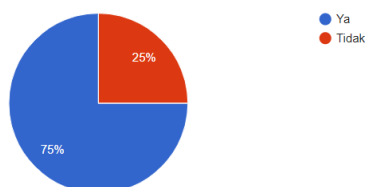32 responses

Figure 3.4 Diagram of the Usefulness of Government Quota AssistanceThe category of intervention from the government by providing quotas turned out to be very helpful for 75% while 25% of students felt they were not helped by the internet quota provided by the government because in their area they could only use a different provider than the provider provided by the government. The next intervention is from the parents and the school. As many as 78.3% of students are less focused in learning.

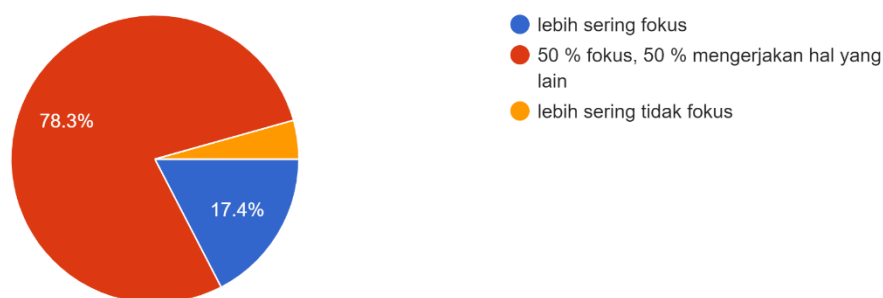Perbandingan ketika saya fokus dan tidak fokus dalam pembelajaran
23 responses

Figure 3.5 Student Focus Diagram in Online Learning

Kegiatan yang saya lakukan katika saya tidak fokus pada proses pembelajaran (jawaban boleh lebih dari 1)
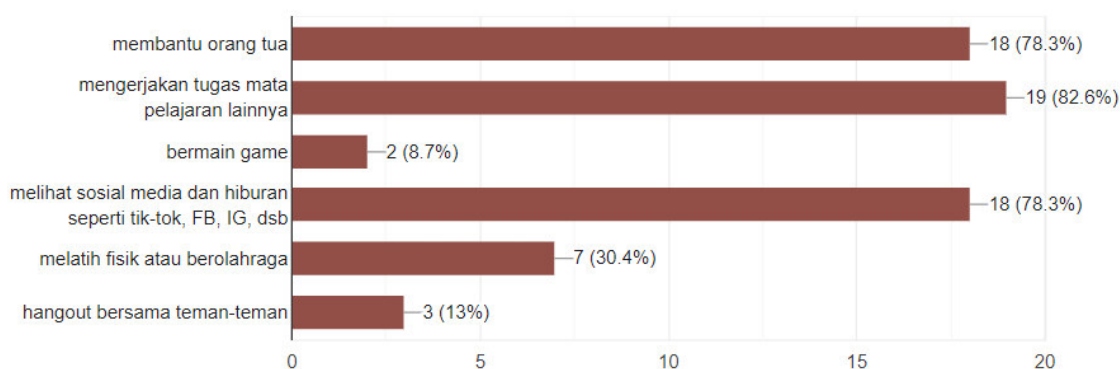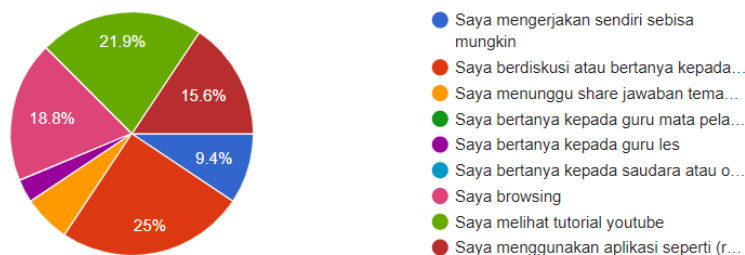
23 responses

Figure 3.6 Reasons for Students' Disfocus in Online Learning

This is due to intervention from parents who do not support learning by asking students to help parents do daily assignments during online learning or do assignments from other subjects. Apart from doing assignments for other subjects and helping parents, what is sad and what has happened to this day after the pandemic is that some students view social media more often, as well as play games during learning. This is corroborated by the results of teacher interviews on student motivation and focus in learning chemistry after the pandemic.

The number of assignments from each teacher, both in chemistry and other subjects, is a burden for students. Even so, most students did not mind the assignments given by the teacher because they felt the assignments were their responsibility and helped them to understand the material. Assignments from teachers in various forms, such as pdf student work results, ppt in groups, as well as making practicum videos "force" students to learn and master technology. When students experience difficulties in doing assignments, 25% of students use peer tutors, 21% of students use YouTube tutorials, 18% of students surf the virtual world, 15.9% use applications from third parties, while others do it themselves, waiting to share answers from friends or ask the tutor.

28. Bagaimana cara Anda menyelesaikan tugas-tugas tersebut? (Jawaban boleh lebih dari 1)

32 responses

- Saya mengerjakan sendiri sebisa mungkin
- Saya berdiskusi atau bertanya kepada…
- Saya menunggu share jawaban tema…
- Saya bertanya kepada guru mata pela…
- Saya bertanya kepada guru les
- Saya bertanya kepada saudara atau o…
- Saya browsing
- Saya melihat tutorial youtube
- Saya menggunakan aplikasi seperti (r…

Gambar 3.7 Diagram of Method of Students' Learning During Pandemic

During the pandemic, several students did not do practicum, so they had difficulty learning the procedural material.

21. Selama semester 1 sampai awal semester 3 (daring 100%) apakah Anda pernah melakukan praktikum?
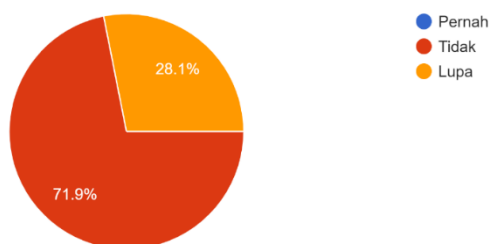32 responses

- Pernah
- Tidak
- Lupa

Figure 4.8 Diagram of Practicum Implementation during Online Learning

Conceptual knowledge is in second place which is difficult for students to understand. Some of them are SPU materials, intermolecular forces, redox, nomenclature, stoichiometry, Faraday's law and intermolecular forces. At first the mole concept was easy for students, but because of the lack of examples and practice questions, students found it difficult when dealing with questions given by the teacher. Metacognitive knowledge is in last place, possibly because students do not understand the meaning of metacognitive.
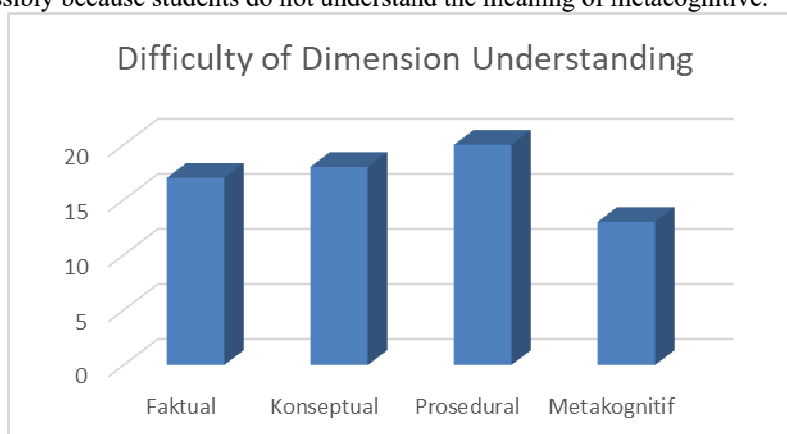

Figure 34.9 Bar chart of Difficulty of Understanding Dimensions of Chemistry Subject
In evaluation, 71% students prefer online assessment.

Berikan alasan Anda mengapa memilih jawaban tersebut!
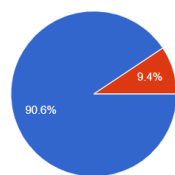
32 responses

Tidak tegang
Karena bisa berdiskusi dengan teman melihat google
karena bisa mengerjakan bersama di kelas
Karena lebih mudah dan simple
Mungkin guru juga sudah tau, biasanya kita bisa banyak berdiskusi dengan teman kita tentang ulangan yang dikerjakan. Jadi hasilnya bisa lebih maksimal. Tapi tidak semua ulangan bisa diberlakukan seperti itu. Kalau yang seperti kuis dan waktu yang memang benar-benar harus dikerjakan sendiri ya harus dikerjakan dengan sendiri. Agar tidak rugi waktu
pasti sudah tau lah jawabannya hehehe

Figure 4.10 Scrrenshoot Questionnaire Why Students C

Students feel more relaxed and calm when the assessment is online. Implementation is also easy and simple according to students. Some choose online assessments because of weak supervision so that they can commit fraud during online assessments. Some students who choose assessment should be done offline to prevent cheating and really assess students' abilities. This can be seen from the decrease in committing fraud when online and offline assessments.

32. Apakah Anda pernah berbuat curang saat ujian online

32 responses

33. Apakah Anda pernah berbuat curang saat ujian offline?
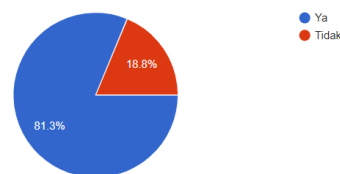
32 responses

- Ya
- Tidak

Figure 4.11 Cheating in Online and Offline Assessments

Although some students feel that it is natural to cheat, students realize that cheating should not be done.

31. Bagaimana pendapat Anda tentang kecurangan pada saat ujian?

32 responses

tidak baik
Ya pastinya ada karena di era ini bukan jujur namun hanya nilai yang dipentingkan
Perbuatan seperti itu tergantung pada diri orang itu masing masing
Menurut saya dari jaman dulu banyak terjadi kecurangan dalam ujian. Saya melihatnya ini wajar, TAPI sebaiknya jangan pernah terjadi. Karena nantinya kita semakin dewasa akan banyak dituntut untuk menjadi orang yang jujur. Jadi sebaiknya jika kita pernah curang maka berhenti sampai situ jangan mengulanginya lagi.
mungkin merasa menyesal pada diri sendiri
Tidak setuju
iyaa,pasti perbuatan itu pasti ada,kalau bisa jawab sebisanya aja
Menurut saya hal ini sudah menjadi suatu kegiatan yang 'wajar' di kalangan siswa. Namun saya sangat

Figure 4.11 Screenshot of Student Opinion Questionnaire Results about Cheating in Assessment

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3.2. Open Coding

Open coding analysis was carried out together with interview transcripts. Open coding is done by using transcripts, and breaking them down into individual excerpts or notes or codes. The notes are made in order to (1) capture the meaning of the text, which part of the dominant meaning is in the text and which meaning can be

contradicted; (2) showing the inherent meanings in a text, especially hidden meanings; (3) analyze how the text relates to life, experience, reality, and meaningful things about the research subject.

Records or codes make it easier for researchers to analyze or compare. Notes are used to record the flow of thoughts as well as material for reflection. These notes are an important part of conducting grounded theory research. Writing notes in grounded theory allows researchers to reflect and record their thoughts about data, coding processes, coding choices, methods of data analysis; helps remember things that might be forgotten; record the traces of decision making; makes it easy to explore phenomena, reflect on available data, compare data, and examine relationships between data. The following is an excerpt of open coding from student interviews
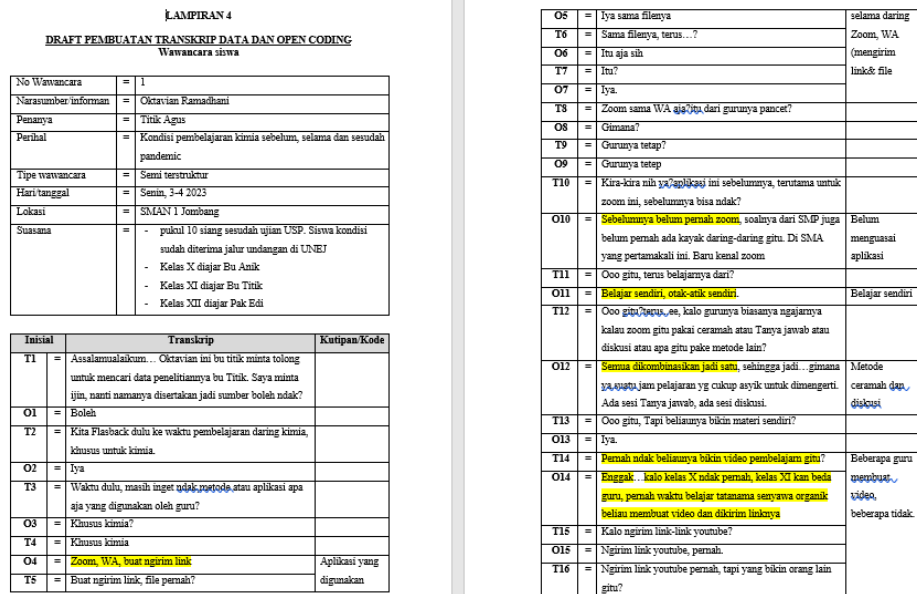

Figure 5.1. Transcript Quote and Open Coding

Data collection is an ongoing process in order to find emerging categories, reformulate them, trim lists, then build theory. The following is an excerpt of repeated data collection that is carried out when there is new data that adds insight.
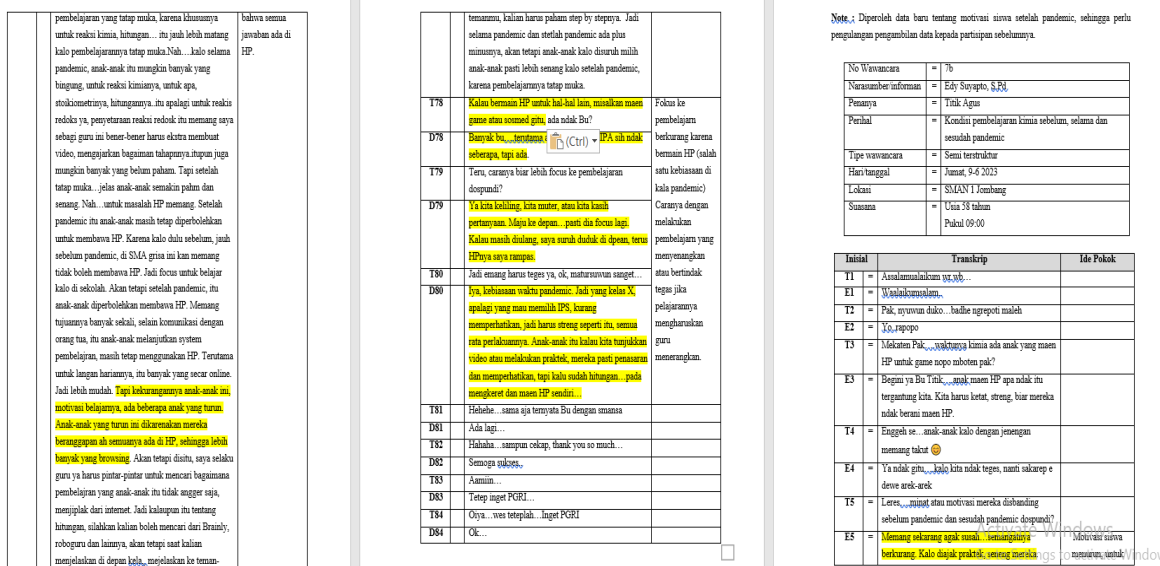

Figure 5.2. Repeated Data Retrieval Quoeto

3.3. Axial Coding

Collection of quotes is done to facilitate the analysis of axial coding (axial coding). Axial coding analysis is the

collection of quotes that represent the same central idea or concept into the same group of categories. Because grounded theory is a cyclical process, after listing the codes, and grouping the codes into categories, the researcher must continue to analyze additional interview transcripts, and compare the new quotes with the existing coded categories. This was continued until it reached the point where additional transcript excerpts did not expand the existing codes and categories. Based on the results of the open scoring, three categories were obtained that linked coding, namely before the pandemic, during the pandemic and after the pandemic. Through axial coding, researchers found that prior to the pandemic, both teachers and students had low mastery of IT, and some had not even mastered technology. Apart from that teachers and books are the only learning resources. During the pandemic the obstacles experienced by students were low understanding and difficulties in understanding procedural and conceptual dimensions because they could not carry out practicums or only learned from videos and the lack of supervision from teachers led to student indiscipline so that they played more on social media and cellphones and there was cheating in online assessments. The advantages of online learning are the increased creativity of teachers and students, the use of various learning applications, increased student independence in the learning process and increased grades
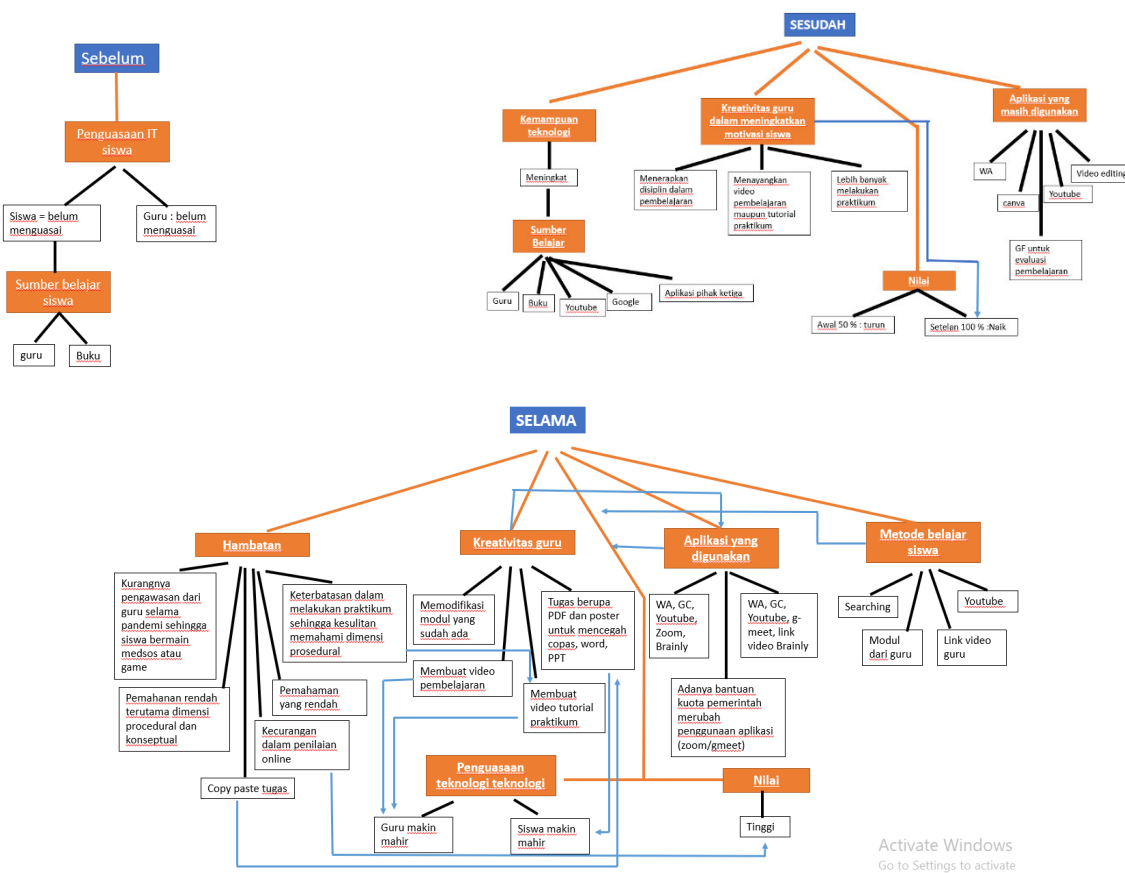

Figure 5.3 Category Grouping

Unfortunately the increase in value is not in line with the increase in student understanding. The increase in value is suspected due to cheating committed by students. This is reinforced by the results of the questionnaire which showed 71.9% of students cheated and real scores, where scores during online assessments were high, while scores in online learning were 50% where assessments were carried out offline with teacher supervision very low. As offline learning takes place, chemistry scores increase significantly

3.4. Selective Coding and Theory

Selective coding is a process for selecting categories in order to find a core or central category, systematically, so that it can be used conceptually to assemble and integrate other categories in a "story" network. Selective coding is done after achieving theoretical saturation in codes and categories. During data collection, repeated data collection was carried out in order to achieve theoretical saturation. Selective coding was done by comparing the quotations obtained with other quotations. This act of comparison is part of a core basic theory method called the constant comparative method. What needs to be considered when comparing is looking for similarities and differences between different quotes from the same person, similar quotes between different people, different

people's experiences in similar quotes, comparing quotes because they differ from one day to the next.
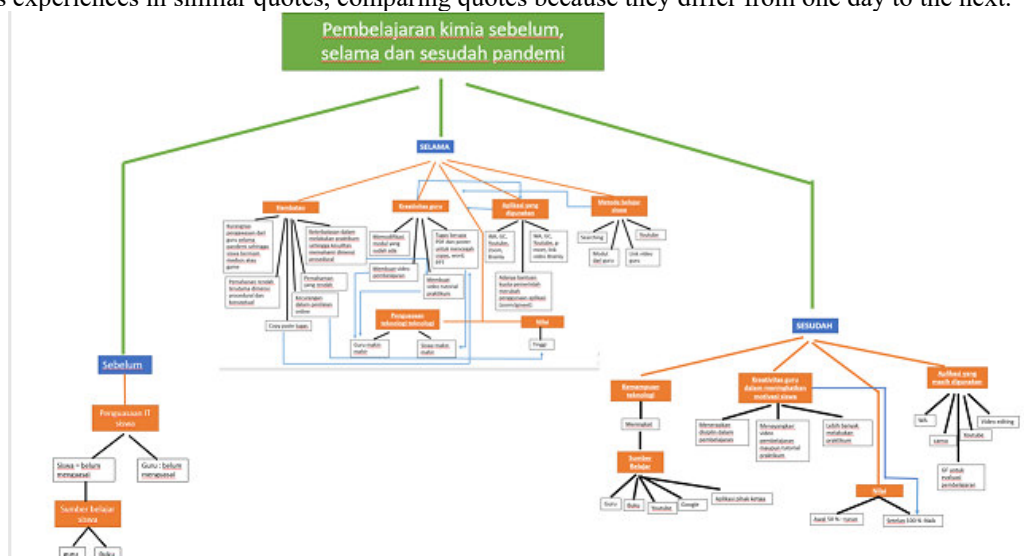

Figure 5.4 Analysis of Selective Coding

Selective coding analysis shows that the existence of a pandemic disrupts the learning process. Teachers are required to be creative and master technology. Whether or not online learning is running depends on the creativity of the teacher and the IT skills of the teacher and students concerned as well as quota assistance from the government. The teacher's creativity includes making learning videos (equalizing reaction equations, chemical stoichiometry, nomenclature of hydrocarbon compounds, geometric isomers), making practical tutorial videos (acid-base identification, buffer solutions, salt hydrolysis), using flasher applications (titrations, thermochemistry, flames, voltaic cells), as well as utilizing existing materials at home such as material for making isomers using plasticine, identifying acids-bases with natural indicators, making batteries using fruits, metal plating using bathroom cleaners. Teachers are required to master technology or online learning applications as well as online learning evaluation. The applications used in online learning during the pandemic were initially only one-way, such as WA, GC, Youtube and videos, which have turned into two-way learning using teleconferences such as zoom, g-meet and webex. This is because the teleconference application requires a large internet quota. Evaluate online using the Google form. Until now the application is still used because it is paperless and efficient. Overall IT skills of both teachers and students increased. After the pandemic, chemistry teachers began to abandon GC and teleconference applications. This is because during the pandemic GC was used as a container for collecting assignments. After the pandemic, assignments were collected and corrected together in class. Teleconferences are starting to be abandoned because face-to-face meetings have started. The WA group is still used as a communication tool for teachers and students as well as sending files and links. Tutorial videos help students make it easier to understand how to work in the laboratory, so they are still used. Students still use YouTube, WA groups, surfing the internet, Canva, video editors and paid applications to help understand material after the pandemic. The disruption in chemistry learning due to the pandemic requires teachers to innovate or be creative.

According to the history of human civilization, we have experienced disruptive or disruption to human social life several times. Literally, the Big Indonesian Dictionary (in kbbi.web.id, 2023) states that disruption is something that is uprooted from its roots ((Badan Pengembangan dan Pembinaan Bahasa (Pusat Bahasa) 2023). From this definition, it can be seen that disruption is a major phenomenon that will overturn established models that already exist in various sectors. The existence of educational disruption or disruptive education in chemistry learning due to the pandemic requires teachers to innovate or be creative. This disruption occurred as an antecedent of the disruption that occurred in three sectors. First, digital disruption or digital disruption. Digital disruption is the flow of changes in values and processes in the industry caused by developments in information and communication technology. This shows that the existence of digital disruption has changed the mindset and logic of the sectors that experience it, including the education sector. This flow changed the education system from text-book based to open resource based. Now, students don't just depend on printed books that are officially used by schools. The second is the disruption of educational institutions where there is a fundamental change in the methods and modes of knowledge transfer within educational institutions. The existence of this flow of change democratizes education for many circles. The third is social disruption, namely changes in patterns in society caused by disruptive innovation. The disruptive innovation theory put forward by Christensen describes how organizations use technology to make products or services more accessible to more people. Disruptive innovation starts with something simple and affordable. Disruptive innovation theory actually describes the

process by which a service transforms an existing market by introducing simplicity, convenience, accessibility, and affordability. The "the jobs to be done theory" framework emerged as a useful way of looking at students' needs by focusing on their underlying motivations. The four characteristics of being disruptive are massive, fast changes with unpredictable patterns (volatility). there is a rapid change that causes uncertainty, the complexity of the relationship between the factors causing the change (complexity) the lack of clarity of the direction of change that causes ambiguity. One of the disruptions that we have been through is the industrial revolution. Those that originally used human labor have switched to mass production using IT machines or based on the use of cyber-physical systems. Even so, this does not necessarily result in people mastering technology on a large scale. Only certain circles master the technology. The existence of COVID-19 caused disruption in all sectors of people's lives. One of the fundamental sectors of life that has been swept away by the currents of disruption is the education sector. This supports the mastery of technology evenly to all levels of society.

Research in a number of cities in Java, Sumatra and Madura shows that there is a decrease in academic achievement due to the lack of application of learning methods, increased student difficulties, learning facilities and infrastructure that are not optimal, and learning that does not benefit students (Ashari and Nugrahanti 2022). In contrast, in our study, students' academic achievement increased, but students' understanding of the material decreased. This is evidenced by interviews and high scores in online learning but scores drop when the assessment is carried out offline. This happened because there was fraud while the other trials were carried out online. An increase in cheating during online assessments also occurred in Turkish students where there was a significant increase in incidents of cheating in online education (Yazici, et al. 2022).
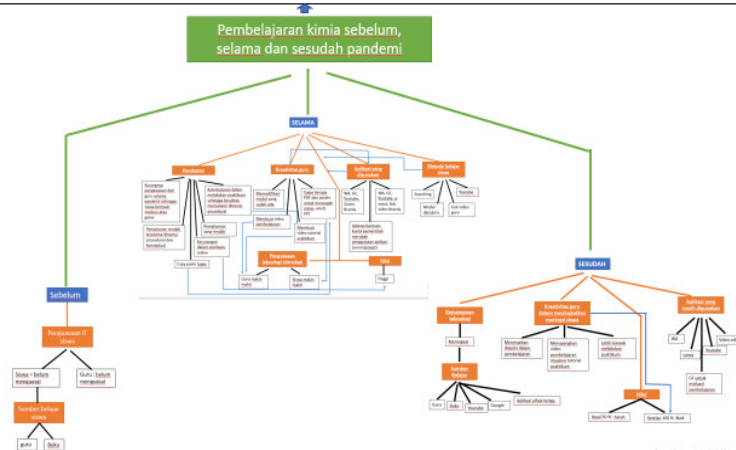
The score decreased when the assessment was carried out offline because most students had difficulty learning chemistry on both conceptual and procedural dimensions. Developing conceptual knowledge cannot be separated from developing procedural skills in the chemistry learning process. Mastery of chemistry teacher technology at SMAN 1 Jombang and SMA PGRI 1 Jombang, it is not possible to create a virtual laboratory. The complexity of the Covid-19 pandemic faced by teachers requires teachers to be very creative in an online learning environment. A teacher is a technical position that is directly connected to education and engages with students and thus requires a high degree of imagination. The role of the teacher as an instructor and instilling good characteristics in a student cannot be ignored. Teachers must do everything possible to ensure that students are well served. The Covid-19 pandemic requires teachers to think creatively in the classroom. A teacher who does not dare to think creatively will face additional obstacles if he wants to improve the way he teaches (Tamsah, Ilyas and Yusriadi 2021). In our research, teachers can take advantage of existing virtual laboratories using flashers (titration, thermochemistry, flames, voltaic cells) or by making practicum video tutorials (acid-base identification, buffer solutions, salt hydrolysis). If possible, you can ask students to do practical work using materials around students such as acid-base materials using natural indicators, isomers using plasticine and metal plating using bathroom cleaners. Learning videos are also a way out when the conceptual dimension material is in the form of calculations that require an explanation of the steps in doing it. Some of the learning videos made by the teacher include balancing reaction equations, chemical stoichiometry, nomenclature of hydrocarbon compounds, geometric isomers. Videos can be viewed repeatedly, when students do not understand enough. Some teachers make videos, some don't, just share a youtube link to learn from. The teacher's limited time, where more time is used to correct student assignments, makes it impossible for the teacher to make a lot of learning videos. Learning videos made by teachers are only limited to use among themselves. This happens because of the teacher's lack of confidence to share. Until now, after the pandemic, students prefer to use the YouTube application for learning. The lack of conceptual understanding is because students with high academic abilities only see once, while students with low abilities, even though they see many times, they understand more when there is two-way communication, where as soon as something is not understood, students can immediately interrupt to ask questions. Before the pandemic, students only knew that YouTube was for entertainment, they did not use YouTube for learning. IT skills have increased, so that after the pandemic, students showed increased independence in learning by using YouTube and Google to surf for answers to questions before asking the teacher in class. Today, teachers really aren't the only source of learning. Before the pandemic, teachers and books were learning resources. During and after the pandemic, students used YouTube, surfed the internet and peer tutored

Some students are greatly helped by peer tutors when working on assignments in groups (cooperative learning). Cooperative learning is effective for students' academic and social learning and can provide individual support for the learning process (Abramczyk and Jurkowski 2020). According to Silalahi and Hutauruk, cooperative learning has been shown to increase student engagement (Silalahi and Hutauruk 2020) but in our research we found that some students did not participate actively in carrying out group assignments, so they needed special attention when giving group assignments.

According to Hasibuan and Anggaini, the phenomenon of teenagers addicted to online games in Deli Tua Village reached its worst point during the Covid-19 pandemic. The average school-age child who is addicted to online games, ranging from 12-18 years old. Many things influence and cause why this phenomenon occurs.

Starting from the youth themselves, parents or family, environmental factors, as well as the learning process followed by teenagers at school. The impact of online game addiction has an impact on aspects of adolescent life which includes health, psychological, academic, social, and financial aspects ((Hasibuan and Anggreni 2022). This continued after the pandemic, so that students' motivation in class decreased. Addiction to online games reduces student academic achievement (Anwar and Winingsih 2021). Decreased motivation due to addiction to playing games and social media can reduce academic achievement, therefore teachers must act decisively and look for learning methods that can motivate students in learning chemistry, for example by doing practicum, showing videos or making posters or infographics. The teacher's assertiveness and creativity in diverting addiction to playing social media and online games so that students are motivated again and focus on learning to improve student learning outcomes as indicated by the increase in grades after the pandemic.

Gambar 5.5 Pembentukan teori

D. CONCLUSION AND SUGGESTION

The results of the study corroborate Christensen's theory of disruptive innovation where to overcome disruption in chemistry learning, teachers and students take action by increasing mastery of information technology, teachers also increase creativity in learning chemistry. The creativity of teachers in chemistry learning includes making learning videos (equalizing reaction equations, chemical stoichiometry, nomenclature of hydrocarbon compounds, geometric isomers), practical video tutorials (identification of acids and bases, buffer solutions, hydrolysis of salts), using flasher applications (titrations, thermochemistry, flames, voltaic cells), as well as utilizing materials at home such as materials for making isomers using plasticine, identifying acids-bases with natural indicators, making batteries using fruits, metal plating using bathroom cleaners. In line with Piaget's constructivism learning theory that the procedural dimension is more meaningful if it is done by doing practicum compared to watching videos. Videos are needed to help students make it easier to understand procedures when practicing in the laboratory. Chemistry understanding in conceptual and procedural dimensions during online learning has decreased.

Suggestions that researchers can give for further research are that the teacher's technological ability in mastering virtual laboratory applications is still lacking, so it is necessary to carry out training on using virtual laboratories and the need to develop practicums using everyday materials around so that learning is more meaningful.

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F. REFERENCES

Abramczyk, Anna, and Susanne Jurkowski. 2020. "Cooperative learning as an evidence-based teaching strategy: what teachers know, believe, and how they use it." *Journal of Education for Tecahing* 296-308.

AlMahdawi, Manal, Salieu Senghore, Horia Ambrin, and Shashidhar Belbase. 2021. "High School Students' Performance Indicators in Distance Learning in Chemistry during the COVID-19 Pandemic." *Education Sciences* 1-26.

Anderson, Lorin W, David R Krathwohl, Peter W Airasian, Kathleen A Cruikshank, Richard E Mayer, Paul R Pintrich, James Raths, and Merlin C Wittrock. 2001. *A Taxonomy for Learning, Teaching and Assessing; A revision of Bloom's Taxonomy of Educational Objectives.* Vol. a Bridged Edition. USA: Longmans.

Anwar, Nabiel Rifqy, and Evi Winingsih. 2021. "Pengaruh Kecanduan Game Online Terhadap Prestasi Akademik Siswa SMP Negeri 5 Banjar Dimasa Pandemi." *Jurnal BK Unesa* 559-571.

Arias, M., Sandia, B. & Mora, E. 2012. "La didáctica y las herramientas tecnológicas web en la educación interactiva a distancia." *Educere* 21-36.

Ashari, Hasan, and Trinandari Prasetya Nugrahanti. 2022. "MENURUNNYA PRESTASI AKADEMIS MAHASISWA AKUNTANSI PADA PEMBELAJARAN DARING DI MASA PANDEMI COVID-19." *Jurnal Revenue, Jurnal Ilmiah Akutansi* 233-251.

Asih, Findiyani Ernawati, Sri Poedjiastoeti, Ahmad Lutfi, Dian Novita, Ismono, and Amalia Putri Purnamasari. 2022. "The practicality and effectiveness of case study-based module on chemical thermodynamics course (ideal and real gases) as learning tool during the COVID-19 pandemic." *Dialnet* 466-483.

Baber, Hasnan. 2020. "Determinants of Students' Perceived Learning Outcome and Satisfaction in Online Learning during the Pandemic of COVID 19." (Journal of Education and e-Learning Research) 7 (3): 285-292.

Badan Pengembangan dan Pembinaan Bahasa (Pusat Bahasa). 2023. *kbbi.web.* Accessed 7 25, 2023. https://kbbi.web.id/disrupsi.

Chan, Philippe, Tom Van Gerven, Jean-Luc Dubois, and Kristel Bernaert. 2021. "Virtual chemical laboratories: A systematic literature review of research, technologies and instructional design." *Science Direct : Computer and Education Open* 1-17.

Chandrasegarana, A.L., David F. Treagust, and Mauro Mocerino. 2007. "TThe development of a two-tier multiple-choice diagnostic instrument for evaluating secondary school students' ability to describe and explain chemical reactions using multiple levels of representation." *Journal of Chemistry Education and Practice* 293-307.

Chang, Tsa-Yu, Ming-Lun Hsu, Jae-SUng Kwon, M.F Lindawati, S. Kusdhany, and Guang Hong. 2021. "Effect of Online Learning for Dental Education in Asia During the Pandemic." *Journal of Dental Sciences* 16 (4): 1095-1101.

Chans, Guillermo M., M.E Bravo-Guiterrez, Angelica Orona-Navar, and Elvia P. Rodriguez-Sanchez. 2022. "Compilation of Chemistry Experiments for an Online Laboratory Course: Student's Perception and Learning Outcomes in the Context of COVID-19." *Sustainability* 1-26.

Churiyah, Madziatul, Andi Basuki, Filianti, Sholikhan, and Muhammad Fikri Akbar. 2022. "Canva for Education as a Learning Tool for Center of Excellence Vocational School (SMK Pusat Keunggulan) Program to Prepare Competitive Graduates in the Field of Creativity Skills in the Digital Age."

International Journal of Social Science Research and Review 226-234.

Creswell, John W. 2012. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research Fourth Edition.* Boston: Pearson.

Danila, Rizza, and Rusdiana Agustini. 2021. "Analisis Keterampilan Metakognitif Peserta Didik Menggunakan Model Inkuiri Terbimbing pada Materi Laju Reaksi Berbasis Pembelajaran Daring." *Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran* 596-606.

Education, Manitoba. 2006. *Rethingking Classroom Assessment with Purpose in Mind.* Manitoba, Canada: Manitoba Education, Citizenship and Youth.

Erna, Maria, Lenny Anwar, and Mazidah Mazidah. 2021. "Interactive e-module using Zoom Cloud Meeting platform to reduce misconceptions on salt hydrolysis material." *Journal of Education and Learning (EduLearn)* 383-390.

Fauziyah, Nabielah Luaily, J. Priyanto Luaily, and Shierly Novalita Yappi. 2022. "The Use of 'Canva for Education' and the Students' Perceptions." *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)* 6368-6377.

Gorbunovs, Aleksandrs, atis Kapenieks, and Sarma Cakula. 2016. "Self-Discipline As a Key Indicator to Improve Learning Outcomes in E-Learning Environment." *International Conference, Meaning in Translation: Illusion of Precision.* Riga, Latvia: Procedia Social and Behavior Sciences.

Handayani, Dewi. 2020. "The Application of The PjBL Model uses WhatsApp and Zoom Meetings in Learning." *International Journal of Chemistry Education Research* 46-52.

Hasibuan, Jubaidah, and Aisyah Anggreni. 2022. "Fenomena Kecanduan Game Online pada Remaja di Desa Deli Tua Kecamatan Namorambe ." *Jurnal CSR, Pendidikan, dan PemberdayaanMasyarakatJurnal Program Studi Pendidikan MasyarakatUniversitas Mulawarman* 20-28.

Hussein, Elham, Sumaya Daoud, Hussam Alrabaiah, and Rawand Badawi. 2020. "Exploring Undergraduated Students' Attitudes Towards Emergency Online Learning During COVID-19: A Case from the UAE." *Children and Youth Service Review* 119: 1-7.

Irfani, Faizal Fakhri, Mohamad Triyanto, Anggit Dwi Hartanto, and Kusnawi. 2020. "Analisis Sentimen Review Aplikasi Ruangguru Menggunakan Algoritma Support Vector Machine." *Jurnal Bisnis, Manajemen dan Informatika* 258-266.

Kartimi, K., R.Y. Gloria, and I.R Anugrah. 2021. "Chemistry Online Distance Learning during the Covid-19 Outbreak: Do TPACK and Teachers' Attitude Matter?" *Jurnal Pendidikan IPA Indonesia* 228-240.

Kennedy, K.M Nowak, S. Sundaram, R. Thomas, and J Davis S.F. 2000. "Academic Dishonesty and Distance Learning : Student and Faculty Views." *College Student Journal* 34: 309-314.

Khairini, Ibnu Khaldun, and Andi Ulfa Tenry Pada. 2021. "The Effect of Student Worksheets Through the Edmodo Network on Concept Understanding and Independent Learning on Hydrocarbon Materials." *Jurnal Penelitian Pendidikan IPA (JPPIPA)* 429-436.

Kominfo. 2021. *Mulai 3 Juli, Pemerintah Berlakukan PPKM Darurat di Jawa-Bali.* https://www.kominfo.go.id/content/detail/35388/mulai-3-juli-pemerintah-berlakukan-ppkm-darurat-di-jawa-bali/0/berita, Jakarta: Kominfo.

Lemay, David John, Paul Bazelais, and Tenzin Doleck. 2021. "Transition to Online Learning During the COVID-19 Pandemic." *Computer in Human Behavior Report* 4: 1-9.

Maatuk, Abdelsalam M., Ebitisam K. Elberkawi, Sadi Aljarwarneh, Hasan Rashaideh, and Hadeel Alharbi. 2022. "The COVID 19 Pandemic and e-learning: Challenges and Opportunities from The Perspective of Students and Instructors." *Journal of Computing in Higher Education* 21-38.

Maqableh, Mahmoud, and Mohammad Alia. 2021. "Evaluation Online Learning of Undergraduate Students Under Lockdown Amidst COVID-19 Pandemic : The Online Learning Experience and Students' Satisfaction." *Children and Youth Service Review* 128: 1-11.

Milda, Suyono, Yuni Sri Rahayu, Eko Hariyono, Binar Kurnia Prahani, and Syubhan Annur. 2022. "Profil of Science Literacy Skill of Junior High School Student on Energy Materials in Living Systems in Online Learning." *AIP Conference Proceedings 2600.* AIP Publishing LLC. 020009.

Misbah, M., Y. Khairunnisa, P.D Amrita, D. Dewantara, S. Mahtari, K. Syahidi, N. Muhammad, B.K. Prahani, and U.A. Deta. 2020. "The effectiveness of introduction to nuclear physics e-module as a teaching material during covid-19 pandemic." *National Seminar of Physics Education.* Banjarmasin, Kalimantan Selatan: Journal of Physics: Conference Series. 1-5.

Mushtaha, Emad, Saleh Abu Dabous, Imad Alsyouf, Amr Ahmed, and Naglaa Raafat Abdraboh. 2022. "The Challenges and Opportunities of Online Learning and Teaching at Engineering and Theoretical Colleges During The Pandemic." *Ain Shams Engineering Journal* 13 (6): 1-13.

Nasional, Tim Komunikasi Komite Penanganan Corona Virus Disease 2019 (Covid-19) dan Pemulihan Ekonomi. 2021. *Setahun Pandemi: Perkembangan Grafik Menjadi Refleksi Kualitas Penanganan.* https://covid19.go.id/p/berita/setahun-pandemi-perkembangan-grafik-menjadi-refleksi-kualitas-penanganan,

Jakarta: Tim Komunikasi Komite Penanganan Corona Virus Disease 2019 (Covid-19) dan Pemulihan Ekonomi Nasional.

Ng, Khar Thoe, Junaidah Jamaluddin, Yee Jiea Pang, Careemah Choong, Yoon Pah Lay, Eng Tek Ong, Kamalambal Durairaj, Corrienna Abdul Talib, and Chee Keong Chin. 2021. "DEVELOPING CONCEPTUAL AND PROCEDURAL KNOWLEDGE/SKILLS OF LIFELONG LEARNERS FROM BASIC TO ADVANCE LEARNING: EXEMPLARS, CHALLENGES AND FUTURE DIRECTION." *DINAMIKA: Jurnal Pendidikan Dasar* 22-35.

Nguyen, Han P., Le Nhu, Emily Doran, Emma Polak, Andreatta Jeremy, Margaret Kerr, and Chu Xu Wei. 2022. "Hybrid Teaching in the Organic Chemistry Laboratory as a Response to the COVID-19 Pandemic." *Currents in Teaching & Learning* 47-54.

Noori, Abdul Qawi. 2021. "The Imoact of COVID-19 Pandemic on Students' Learning in Higher Education in AFganistan." *Heliyon* 1-9.

Palacio, E., A. Figuerola, M.A. Vargas-Munoz, L. Ferrer, and J.G. March. 2022. "STUDY OF THE EFFECTIVENESS OF PRE-LABORATORY VIDEOS ON ENHANCING STUDENTS' SKILLS AND PERFORMANCE IN THE ANALYTICAL CHEMISTRY PRACTICAL CLASSES." *15th annual International Conference of Education,Research and Innovation.* Seville, Spain: Iated Digital Library.

Paristiowati, Maria, and Zulmanelis. 2020. "The Effect of Google Clasroom as A Tool in Chemistry Learning." *International Join Conference on Science and Enginering* 415-420.

Prahani, Binar Kurnia, Budi Jatmiko, Tan Amelia, Shalsa Billa Ardhana Neswary, Kirana Aureola Arzak, and Nova Allysa Qotrunnada. 2022. "Research Profile of Discovery LearninginPhysics Learning During the COVID-19 Pandemic." *JPPPF (Jurnal Penelitian danPengembangan Pendidikan Fisika)* 202-220.

Pratama, Ahmad R., and Lori L. Scarlatos. 2020. "The Roles of Device Ownership and Infrastructure in Promoting E-Learning and M-Learning in Indonesia." *International Journal of Mobile and Blended Learning (IJMBL)* 16.

Putri, Yola Dewi, Rina Elvia , and Hermansyah Amir. 2021. "Pengembangan Media Pembelajaran Kimia Berbasis Android untuk Meningkatkan Motivasi Belajar Peserta Didik." *ALOTROP* 168–174.

Ramdani, Agus, Gunawan, Agus A. Purwoko, and Muhammad Yustiqvar. 2021. "Improving Scientific Creativity of Teacher Prospective Students: Learning Studies Using a Moodle-Based Learning Management System During the COVID-19 Pandemic." *Advances in Engineering Research.* Atlantis Press. Proceedings of the International Joint Conference on Science and Engineering 2021 (IJCSE 2021).

Shidiq, A.S., A. Permanasari, Hernani, and Hendayana. 2020. "Chemistry teacher responses to learning in the COVID-19 outbreak: Challenges and opportunities to create innovative lab-work activities." *International Conference on Mathematics and Science Education (ICMScE) 2020.* Jawa Barat: Journal of Physics: Conference Series. 1-7.

Silalahi, Tiodora Fermiska, and Ahmad Fakhri Hutauruk. 2020. "The Application of Cooperative Learning Model during Online." *Budapest International Research and Critics Institute-Journal* 1683-1691.

Slavin, Robert E. 2006. *Educational Psychology Theory and Practice Eighth Edition.* United State of America: Pearson A and B.

Sobaih, Abu Elnasr E., Amany E. Salem, and Ahmed M. Hasanein. 2021. "Responses to COVID-19 in Higher Education: Students' Learning Experience Using Microsoft Teams versus Social Network Sites." *Sustainability* 1-12.

Sokrat, Hafid, Soumia Tamani, Mohammed Moutaabbid, and Mohamed Radid. 2014. "Difficulties of Students from the Faculty of Science with Regard to Understanding the Concepts of Chemical Thermodynamics." *Procedia_Sosisal and Behavioral Sciences* 368-372.

Syahruddin, Syahruddin, Mohd Faiz, Mohd Yaakob, Abdul Rasyad, Arif Wahyu Widodo, Sukendro Sukendro, Suwardi Suwardi, et al. 2021. "Students' Acceptance to Distance Learning During Covid-19: The Role of Geographical Areas Among Indonesian Sports Science Students." *Heliyon* 7: 1-9.

Tamsah, Hasmin, Jamaluddin Bata Ilyas, and Yusriadi Yusriadi. 2021. "Create Teaching Creativity through Training Management, Effectiveness Training, and." *Journal of Ethnic and Cultural Studies* 18-35.

Urquizo, Elena, Narcisa de Jesús Sánchez, and Monserrat Orrego. 2022. "EXPERIMENTAL ACTIVITIES USING VIRTUAL SIMULATORS TO LEARN CHEMISTRY DURING COVID-19 PANDEMIC." *Revista Chakiñan.*

Wibowo, F C, D R Darman, B K Prahani, and N M Faizin. 2022. "Optics Virtual Laboratory (OVL) Based on Physics." (Journal of Physics: Conference Series) 1.

Wu, D. 2001. "Promoting Understanding of Chemical Representations: Students' Use of a Visualization Tool in the Classroom." *Journal of Research in Science Teaching* 821-842.

Yazici, Sedat, Hatice Yildiz Durak, Beiza Akzu Dunya, and Burcu Senturk. 2022. "Online versus face-to-face cheating: The prevalence of cheating behaviours during the pandemic compared to the pre-pandemic among Turkish University students." *JCAL : Journal of Computer Assisted Learning* 231-254.

Yu, Julia, Fong Chang, Ling-Hsia Wang, Tzu-Chiang Lin, Feng-Chou Cheng, and Chun-Pin Chiang. 2021. "Comparison of Learning Effectiveness Between Physical Classroom and Online Learning for Dental Education During the COVID-19 Pandemic." *Journal of Dental Sciences* 1281-1289.

Yusuf, Nasrullah. 2021. "The Effect of Online Tutoring Application on Student Leraning Outcomes during the COVID-19 Pandemic." (Italienisch) 11 (2): 81-88.

Zan, Nuray. 2019. "Communication Channel between Teachers and Students in Chemistry Education: WhatsApp." *US-China Education Review A* 18-30.