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Analyzing Learner's Computational Thinking in Designing Home ISP Service Structure

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Keywords

computational thinking, case studies, problem solving, designing

Abstract

This study aims to analyze the ability of computational thinking in solving network structure design case study problems. This study presented a case study method given to participants of the research . They were also given fifteen interview questions to the research subjects at SMK Negeri 2 Salatiga. The interview questions posed contain meaning and computational thinking skills that have been adopted and adapted to the existing problems. The results of this study indicate that students can identify and extract relevant information, divide complex problems into small parts and determine priorities which are the key to problem solving, identify and find similarities in problem solving patterns, compare and map problem solving concepts, design a sequence of problem solving steps in a structured and logical manner, be able to evaluate and assess the solutions they design to solve the problems in the case study.

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INTRODUCTION

Education aims to educate human character to have noble morals and act positively in society. The learning process is directed by the teacher so that students gain experience and knowledge in accordance with their fields. Information and communication technology now affects almost all aspects of human life. The ability of humans to use or operate technology is growing rapidly even in all circles. Nurhadiyanto (2007) stated Human resources must have high-level thinking, problem-solving skills, and collaborative work skills to adapt to changes in the workplace in the future. The ability to build and adapt knowledge, attitudes, and skills based on experience and context becomes very important in an uncertain work environment (Didik Nurhadiyanto &; Wagiran, 2007).

In today's era of increasingly advanced globalization, there are increasingly high demands for quality work, with free competition and an increasing need for DU/DI. This results in better human resources. As the 21st century prioritizes quality in both the processes and outcomes of a modern workforce, the increasingly innovative demands of DU/DI necessitate new ideas, concepts, and prestative work behaviors. It can be interpreted that a paradigm or perspective is needed on self and its environment, said the philosopher Kuhn (Thomas S. Kuhn, 2012).

Since the publication of Wing's article in 2006, studies and research on computational thinking have become massive, (Saritepeci, 2020; Zitouniatis et al., 2023) utilize learning models to develop computational thinking. (Durak &; Saritepeci, 2018; Román-González et al., 2017; Santoso, 2021) examines CT through certain factors, Cansu (2019) provides a critical perspective on CT and the potential benefits of computational thinking (Cansu &; Cansu, 2019).

According to Wing, computational thinking is an approach to problem solving, systems design, and understanding human behavior that describes the basic concepts of computing. Computational Thinking has four important stages: a.) Decomposition, in which case the problem is broken down into smaller, more manageable problems. Thus, each of these problems can be solved separately and the source can be determined. b.) Pattern Recognition: Students are expected to look for patterns in this second stage. There is usually a certain pattern to solve the problem. C.) Abstraction, i.e. the general principles that lead to these patterns, trends, and principles must be identified and generalized. This is very important because usually a problem-solving model can be created by looking at its general characteristics. Students should create step-by-step instructions for solving the same problem, at this stage so that others can use the steps and information to solve the same problem (Wing, 2006).

This research uses case studies on designing networks that are relevant to the material learned in class. In the case study method, it means digging up information and conclusions from the observed cases, said Rahardjo (2017). In making case studies, it is necessary to choose quality and relevant cases to be the theme of research, and not all problems or questions can be used as material for case studies or research questions. There are certain prerequisites for an opportunity to become a contextual investigative research case and there is a requirement to ask questions as research questions (Rahardjo, 2011).

Evaluation and assessment of student learning outcomes in the classroom is very important, which is used as a benchmark for student learning achievement (C. Keith Waugh &; Norman E. Gronlund, 2012). According to Andrade (2009), extensive research has not been conducted to test classroom assessment strategies in which learning shows which is more effective (Andrade et al., 2009), as well as assessment of important 21st century skills such as computational thinking skills that teachers do not yet know how to teach and assess these abilities (Griffin &; Care, 2015). Ansori (2020) said that in Indonesia, studies on Computational Thinking and its practical implementation have not been widely applied in schools, thus the assessment of computational thinking skills has not been widely thought of (Ansori, 2020).

According to Ansori (2020), the best method to measure computational thinking skills is to use Assessment as Learning where assessment is learning. Students learn to be their own best assessors through Assessment as learning. Students must also be able to motivate themselves and use their skills and knowledge when deciding how to deal with problems in the problems they face (Anisah, 2022). Students will be encouraged to reflect and consider learning strategies through effective assessment to work on what they need to solve and complete. Arend & Kilcher say that assessment as learning is designed to help students become independent in understanding their own potential by continuously engaging students in self-assessment and peers to get feedback on learning improvements (Arends & Kilcher, 2010) Because peer assessment can aid self-assessment, these assessment methods are often combined or considered together. Students gain insight into their own performance by evaluating the work and answers of their peers (Stephen Bostock, 2007). Computational thinking emphasizes higher-order thinking processes, so students are required to demonstrate their thinking processes in various ways (Ahonen &; Kankaanranta, 2015).

Ahoen and Kankaanranta say the think-aloud method is the best way to assess students' thinking skills. Can be used to analyze differences in a person's problem-solving ability and factors that affect problem-solving learning. This approach can be used to validate and build theories regarding a person's cognitive processes. According to Marsha E. Fonteyn, this is so that assessors can determine, through the use of the think-aloud method, the information available to students when they solve problems and how that information can be used to solve subsequent problems. (Fonteyn et al., 1993).

There are two ways to collect student think-aloud data, namely by concurrent think-alouds and retrospective think-alouds. The opinion of Jacqueline P. Leighton and Mark J. Gierl (Ansori, 2020) concurrent think-alouds, where students or students verbalize the contents of their thoughts during the problem-solving process. Then the opinion of M. Iqbal Farras Pratama (2019), Students revealed their thought processes during the retrospective assessment of think-alouds after completing problem-solving tasks (M. Iqbal Pratama et al., 2019). If testing is carried out to measure students' computational thinking skills, concurrent think-aloud has advantages, because the process of taking data from students is obtained directly from short-term memory or how students first try to solve problems that have been faced (Mueller et al., 2017)

Lisa M. Henjes and Lincoln N. (2007) say that in the think-aloud method, students are asked by teachers to say or say what they think and how to solve any given problem. With the student expressing his or her thoughts verbally. If students have a good understanding of their own perception of a problem, then students will be ready to answer and express what is on their minds. With this think-aloud method, it is expected to get deeper and systematic data, so that the purpose of computational thinking analysis research can be achieved optimally (Lisa M. Henjes &; Lincoln, 2007).

Several previous studies on Computational Thinking analysis targeted research subjects on college students, high school students and junior high school students as has been done by (Kawuri et al., 2019; Princess, 2022; Santoso, 2021; Yuntawati et al., 2021) Broadly speaking, research topics taken from several previous studies analyze how students' computational thinking skills in solving problems in related subjects. (Fawwaz &; Maki, 2022) utilize Computational Thinking to improve the Python programming language skills of vocational students.

Previous research has shown that Computational Thinking has different concepts and subjects in the realm of education. However, there has been no research that focuses on the ability of Computational Thinking in solving complex problems in accordance with real practice in the world of work, especially in majors in Vocational High Schools (SMK). Therefore, this study will focus on the Computational Thinking ability of vocational students in solving cases in accordance with the field studied at school.

METHOD

The research method used is a case study research method, case study method research is a research method that focuses on a deep understanding of a specific case or phenomenon in a particular context. This method can describe complex situations in detail and help in developing a theoretical understanding of the phenomenon being studied. Case studies refer to the investigation of empirical facts regarding a phenomenon that occurs in real and contextual circumstances (Yin Robert, 2014).. The case study method involves collecting data from various sources, such as interviews, observations, documents, and related literature. The data is then analyzed in depth and interpreted with various analysis techniques.

Assessment as Learning or Assessment as learning is important in measuring Computational Thinking because it emphasizes higher-order thinking processes (Ahonen &; Kankaanranta, 201: 5). The think-aloud method is the most effective way to assess students' thinking skills, as it reinforces data descriptions based on interview results and computational thinking skills tests given to all students. Concurrent think-aloud has advantages, because the process of taking data from students is obtained directly from short-term memory or how students first try to solve problems that have been faced, so that the results of thoughts and answers are pure that are still not contaminated by other perceptions that enter the minds of students, so as to be able to express the contents of their thoughts appropriately about the knowledge and abilities of students. So, in this study will use the concurrent think-aloud method with interviews of research subjects. This research was conducted at SMK Negeri 2 Salatiga

At the initial stage, the selection of case study topics on network structure design as a means of testing for SMK Computer and Network Engineering students. Instructions are given to remember and analyze how their group members solve problems and use skills in finding information to answer and complete tasks. The relevance between the research subject and the problem topic raised must exist so that the subject provides a deep

understanding of the phenomenon being researched Yin R. K. (2014). Next will be conducted direct interviews with research subjects as they completed tasks, and recorded all research subjects' comments (Galitz, 1997).

Data Analysis Techniques

This study used interviews with research subjects and recorded the audio. The data is then categorized, numbered, and transcribed using salyns.prosa.ai website. The data that has been converted into text form is then analyzed using the Nvivo application with in vivo coding techniques. An inductive approach is used to prevent overinterpretation of raw data and maintain the point of view of the research subject. Thus, in vivo coding techniques help maintain the point of view of research subjects and prevent overinterpretation of raw data (Thornberg &; Charmaz, 2014).

The first thing to do is enter all the interview data that has been transcribed into text into the Nvivo application used as Figure 1

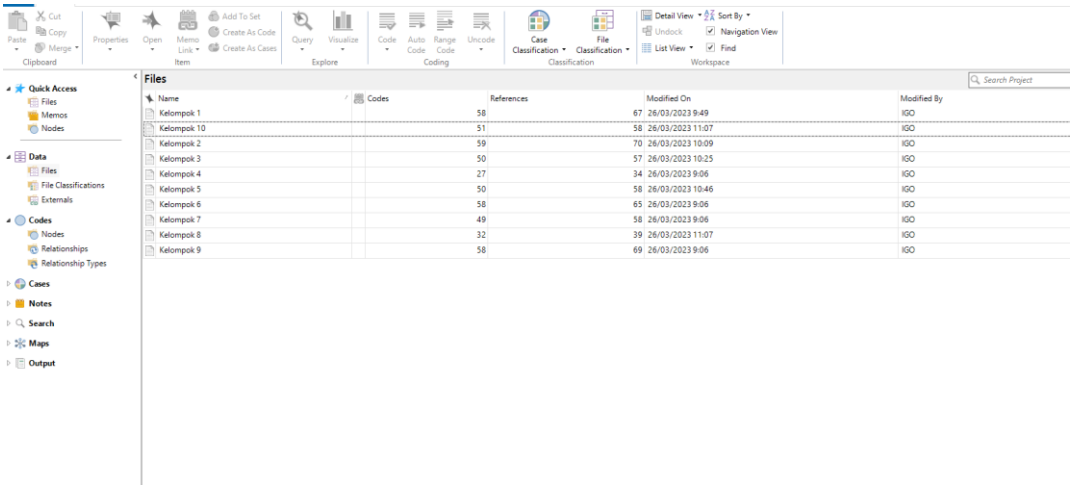


Figure 1. Input interview data files in the Nvivo application

After entering the interview data into the Nvivo application, the next step is to create a node. In the main node a section adjusts to computational thinking skills, the node created in figure 2

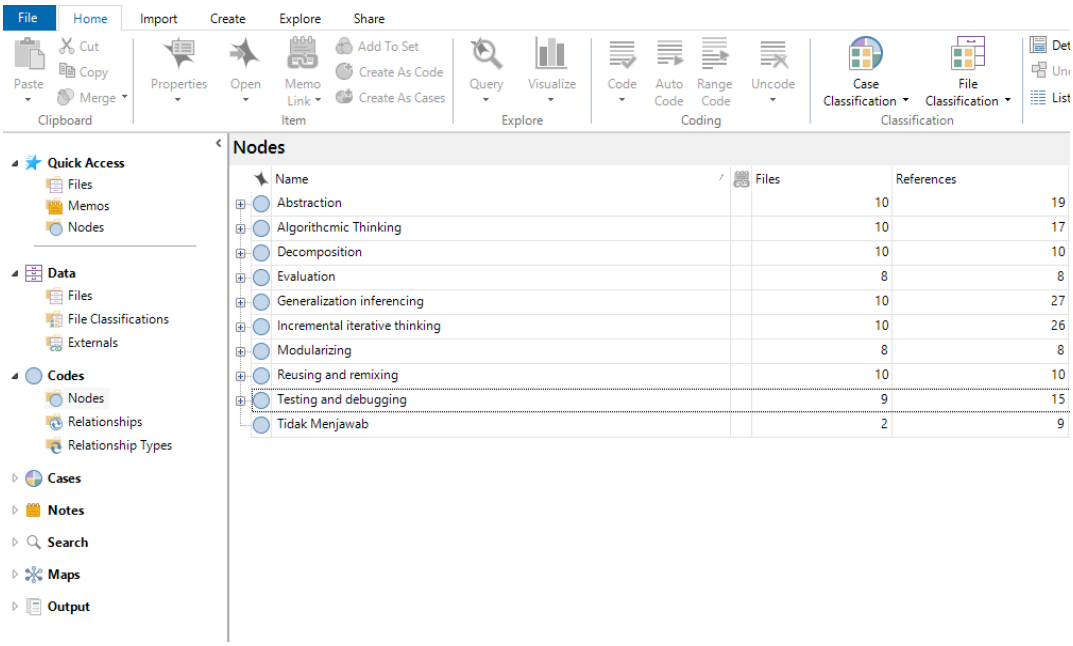
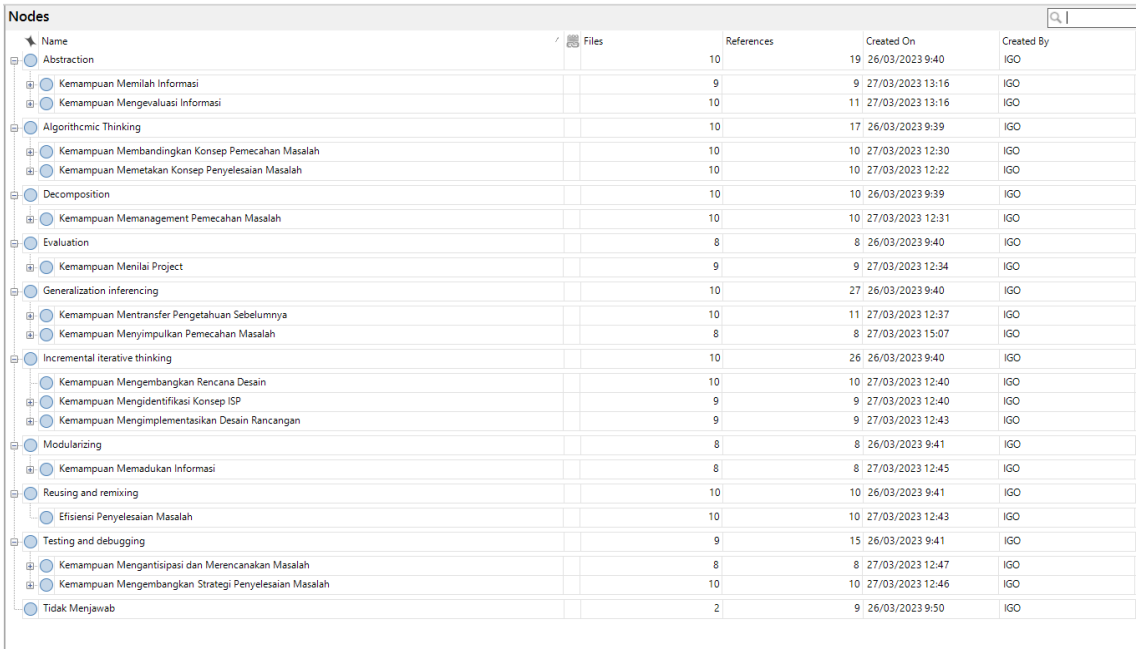


Figure 2. Node computational thinking skill

Furthermore, create node for CT skills such as Abstraction, Algorithmic Thinking, Decomposition, Evaluation, Generalization Inferencing, Incremental Iterative Thinking, Modularizing, Reusing and Remixing, and

Testing and Debugging. There is also a "No Answer" node to keep groups that cannot answer questions contained in the data. After creating nodes, the next step is to enter interview answers into each node that corresponds to that skill.

After entering interview answers into each category of computational thinking skills, sub-nodes were created in each category of computational thinking skills in figure 3 and interviews and case studies were raised



Nodes

Name	Files	References	Created On	Created By
Abstraction	10	19	26/03/2023 9:40	IGO
Kemampuan Memilah Informasi	9	9	27/03/2023 13:16	IGO
Kemampuan Mengevaluasi Informasi	10	11	27/03/2023 13:16	IGO
Algorithcmic Thinking	10	17	26/03/2023 9:39	IGO
Kemampuan Membandingkan Konsep Pemecahan Masalah	10	10	27/03/2023 12:30	IGO
Kemampuan Memetakan Konsep Penyelesaian Masalah	10	10	27/03/2023 12:22	IGO
Decomposition	10	10	26/03/2023 9:39	IGO
Kemampuan Memanagement Pemecahan Masalah	10	10	27/03/2023 12:31	IGO
Evaluation	8	8	26/03/2023 9:40	IGO
Kemampuan Menilai Project	9	9	27/03/2023 12:34	IGO
Generalization inferencing	10	27	26/03/2023 9:40	IGO
Kemampuan Mentransfer Pengetahuan Sebelumnya	10	11	27/03/2023 12:37	IGO
Kemampuan Menyimpulkan Pemecahan Masalah	8	8	27/03/2023 15:07	IGO
Incremental iterative thinking	10	26	26/03/2023 9:40	IGO
Kemampuan Mengembangkan Rencana Desain	10	10	27/03/2023 12:40	IGO
Kemampuan Mengidentifikasi Konsep ISP	9	9	27/03/2023 12:40	IGO
Kemampuan Mengimplementasikan Desain Rancangan	9	9	27/03/2023 12:43	IGO
Modularizing	8	8	26/03/2023 9:41	IGO
Kemampuan Memadukan Informasi	8	8	27/03/2023 12:45	IGO
Reusing and remixing	10	10	26/03/2023 9:41	IGO
Efisiensi Penyelesaian Masalah	10	10	27/03/2023 12:43	IGO
Testing and debugging	9	15	26/03/2023 9:41	IGO
Kemampuan Mengantisipasi dan Merencanakan Masalah	8	8	27/03/2023 12:47	IGO
Kemampuan Mengembangkan Strategi Penyelesaian Masalah	10	10	27/03/2023 12:46	IGO
Tidak Menjawab	2	9	26/03/2023 9:50	IGO

Figure 3. Node and Sub-node

Here are the sub-nodes present in each skill of computational thinking a.) Abstraction, the ability to sort information and evaluate information, b.) Algorithmic Thinking, The ability to compare problem-solving concepts and map problem-solving concepts, c.) Decomposition, Problem-solving management skills, d.) Evaluation, Ability to assess projects, e.) Generalization Inferencing, The ability to transfer prior knowledge and infer problem solving, f.) Incremental Iterative Thinking, Ability to develop design plans, identify ISP concepts and implement design designs, g.) Modularizing, the ability to integrate information, h.) Reusing and Remixing, Efficiency issues, i.) Testing and Debugging, Ability to anticipate and plan problems, develop problem-solving strategies.

DISCUSSION

Assessment as Learning: Concurrent think aloud

Assessment as learning dapat membantu subjek penelitian merefleksi diri dan memahami proses berpikir mereka saat menyelesaikan persoalan atau tugas, proses ini juga dapat dibantu oleh anggota kelompok yang lain dalam melakukan refleksi dan penilaian antar teman, hal ini sangat diperlukan ketika mereka harus berbicara secara verbal tentang apa yang mereka pikirkan dan lakukan saat menyelesaikan sebuah masalah atau persoalan. Dalam pengambilan data menggunakan metode concurrent think aloud bertujuan untuk memahami proses berpikir subjek penelitian saat mereka menuntaskan studi kasus. Dalam penelitian ini meminta subjek penelitian untuk mengungkapkan setiap hasil dari pemikiran mereka yang membentuk sebuah keputusan dan evaluasi.

Penelitian ini mengadopsi sembilan skill computational thinking dan diwawancarai sesuai dengan poin keahlian yang sesuai dengan topik penelitian. Hasil wawancara akan dipaparkan melalui poin-poin penting yang disimpulkan sesuai dengan skill computational thinking dan penyebutan kelompok dalam penjelasan akan dipersingkat dengan "K".

Abstraction

In the ability to sort information, out of 10 groups that can distinguish the information needed to solve problems, only 9 groups succeed because there is information that is considered less relevant such as component prices, network equipment brands, and network topologies. Information on prices, network device brands, and

network topologies is obtained by several groups. The research subject gives reasons why the information is not needed to solve the case study problem such as the following

"... irrelevant karna is not used", (K1)
"... because that information doesn't solve the problem". (K2, and K3)

The entire group was able to answer questions related to their ability to evaluate the information they obtained during the completion of the case study. However, some groups found the information less relevant and there were two groups that could not provide details regarding the results of the evaluation of the information they obtained. The type of information that is less relevant is the same as the answers expressed by the previous research subjects, namely about component prices, component brands, and network topology. Of the 8 groups that mentioned less relevant information such as component prices were K 2, K 8, and K 10. Then information about component brands is found by K 4 and K 9, then information about network topology is mentioned by K 3, K 6 and K 7. Then there are 7 groups that can state the results of their evaluation of information that is relevant or needed in answering the problems in the case study, as follows

"... Examples are needed in the algorithm of running the internet". (K6)

In addition, they also mentioned that relevant information in addition to internet algorithms used in solving problems is information about network installations, and network devices themselves. K6, K 7 and K 9 state internet algorithms. Then K7 also states the network installation. Furthermore K 1, K 5, K 8, K 9, and K10 state that the relevant information is such as a network device.

In abstraction skills, it can be concluded that the research subject has expertise in abstraction abilities, especially in the ability to sort and evaluate information. They are able to identify the type of information needed and evaluate the relevance of that information in solving a given case study problem. In designing the structure of the internet network, they are able to identify relevant information such as internet algorithms, network devices, network installations, and network configurations, while ignoring information that is considered less relevant or irrelevant such as brand, price, and network topology. This is in accordance with the statement (Wing, 2006) that in abstraction this is the ability to identify and extract important information from a particular problem or situation, and set aside irrelevant information.

Algorithmic thinking

In the ability to compare problem-solving concepts , research shows that only 8 groups can compare problem-solving concepts in case studies with schoolwork projects they have received or completed. The schoolwork projects they compared to case study problem solving included projects of coding, cooking, assembling computers, and building smart home technology. K5 and K7 compare solving a case study problem with a coding project to create a website, while K 1 and K10 compare it to cooking. Some students also brought the results of their projects in the form of smart home technology, such as automatic animal feeding devices that can be operated via mobile phones. One of the groups explained the concept of working on the project as follows

"... I didn't know what it was, maybe what it was, look for references first, look for steps, how to tools, what materials run out, it will be made like a chart, sir, like how the structure is made, how is it, sir, there is a proposal too, yes, in that step step, sir, yes, just make it, sir" (K6)

Then in algorithmic thinking has the ability to map the concept of problem solving by planning the sequence of activities that must be carried out to solve the problem. In the study, there are eight main activities expressed by the research subjects, one of which is building knowledge about internet algorithms, network devices needed, network installation, and network configuration. Then the next activity expressed by the research subject was to review the field, but this activity was only expressed by six groups. After they reviewed the field, the next activity carried out was to determine the network devices needed in accordance with the needs of the field, K2 said:

"... the distance between the house and the server was about four kilometers, so Marco needed four kilometers of FO cable" (K2),

There are nine groups that state activities to determine the network equipment needed. Seven groups mentioned that they designed the network design using Cisco Packet Tracer software. After that, K2, K6, and K9 reported the design they had made to his uncle. The sequence of such activities is based on the percentage of answers often submitted by research subjects. There are several explanations presented by students that are interesting and not explained by other research subjects, one of the interesting points is self-evaluation, One group mentions

"... cross check to make sure what he understands is valid." (K9)

Then found several points mentioned by the research subject where the point is a detailed activity, the point of the activity is confirmation with the client which is expressed as follows

"... Confer with the parents who had assigned for the internet period after that already know the consent of parents like this". (K5)

Another detailed activity that is only conveyed by K1 and K10 is the implementation of the design they have made.

This study found that in algorithmic thinking skills, there are skill points, comparing problem-solving concepts, and mapping problem-solving concepts. Research subjects can broadly compare the problem-solving concepts in case studies with what they have done before, especially on schoolwork projects whose output can be realized and become a real solution. Research subjects can also explain what series of activities they will do to solve the case study problem. However, there are only three groups that explain in detail such as reporting progress, confirming with clients, and evaluating themselves. In algorithmic thinking to solve problems requires the ability to design a systematic and logical sequence of activities (Wing, 2006).

Decomposition

In problem-solving management skills, the whole group can answer questions. The subject of the study answered that the most important thing to do is the activity of finding out information. There are 7 groups that mention information about network installation demands, network devices, network device configurations and compiling network structure designs. K2 and K6 gave reasons that they carried out such information seeking activities based on the level of convenience, they stated

"... In my opinion, the easiest is that it is completed and very important it is...". (K2)

Then from the 7 groups there are 5 groups that provide reasons why they are looking for information first, for example as follows

"... If you already know the basics, later we want to make a design, continue to determine the tools and materials, so it's easy". (K6)

In this problem-solving management ability interview, there were three groups who answered the activity of finding out about internet algorithms, namely K5, K8 and K9. According to them, information about internet algorithms is the most important thing in solving this case. One of the group replied

"... the first is to find out first about the structure and the algorithm, if we don't know at first the next step will definitely be confused" (K5),

Thus, according to K5, the reason for finding out about the internet algorithm itself so as not to feel confused when solving problems in case studies, this opinion is supported by the reasons of other groups who state

"... because from there we will know and know about the tools and tools and the thighs and build the image" (K8).

Decomposition is the ability to divide complex problems into small, easily solvable parts (Wing, 2006). Evaluation of this decomposition skill found that research subjects can prioritize what steps they will take to solve problems, the step prioritized by research subjects is to build knowledge about the internet itself, the reason this is done to facilitate the next step in solving case study problems.

Evaluation

On the ability to evaluate the results of problem solving, 9 groups gave answers and 7 of them considered the method they used effective, but only 3 groups gave reasons why. The first states

"... because the solution I get is from people who are experts and experienced in terms of network installation" (K10),

from this sentence it was found that K10 evaluates the problem-solving solutions they use with the sentence "good" reasoned that the source of information or data they use to solve problems is sourced from experienced people, so the positive points of the evaluation carried out by K10 utilize reliable sources in solving problems in case studies, as well as K6 which states that the solution they provide is a good solution Because it utilizes experienced people to help install the internet network. Then one of the groups stated a good solution on the grounds of

"... the solution I provide has also been structured starting from finding out, surveying the place, making designs and implementing it" (K2),

From this sentence, it was found that K2 evaluated the solution given was a good solution because what they had planned and done formed a structured and clear solution.

In addition, interesting answers were found from 2 groups of research subjects, namely K1 and K9. K1 evaluates the results of solving the problems they make is not a solution that is not good enough, because they give reasons

"... Because Marco would have no idea about the algorithms of an internet and how the internet can exist and we can use ..." (K1),

From this explanation, it was found that K1 considered the solution not good because the actors in this case study would not get the knowledge or wisdom gained from solving the problems in the case study. Then K9 could not be sure about the solution they provided, K9 had a reason

"... because situations have different conditions and different solutions..."(K9),

From this statement K9 doubts the solution they use to solve the problem, because K9 understands that in designing networks have different solutions and depend on client needs.

From this skill evaluation, after evaluating the answers of the research subjects, almost the entire group can evaluate the solutions made, but there are only five groups that assess and give reasons for the solutions that have been made. Wing (2006) stated that in the evaluation stage, in addition to being able to evaluate solutions, there is also a process of determining whether the solution is effective or not. Of the five groups, they considered that the solutions provided were fairly effective because they evaluated that the solutions they provided had structured solutions to solve existing problems, had quality reliable information sourced from experts in their fields, had conditional properties, and long-term investment in science.

Generalization Inferencing

On the ability to transfer previous knowledge carried out by the research subject, the whole group can answer questions. After observing and analyzing the coding of the interview data, it was found that the answers expressed by the research subjects implicitly stated that the source of information they had previously obtained was sourced from internal schools and from outside schools. There are 9 groups that imply that they previously received information that they could use to help solve this case study problem, for example as revealed below

"... That is information about network devices, sir, we classmates have been taught about network tools and what their functions are" (K7).

This is also supported by the answer expressed by k8

"... yes because we discussed FO and FO splicing in the previous meeting" (K8).

Thus, it can be concluded that the information obtained by these 9 groups was previously obtained from schools. The type of information obtained regarding network configuration and peripherals or network devices. Information about network configuration is mentioned by K1, K3, K5, K9. Then information regarding network configuration mentioned by K1, K2, K4, K6, K7, K8, K1 answers both points that are generally mentioned by the overall research subjects and states

"... That material could have been used to solve Marco's current problem" (K1)

prove that the information obtained previously has the same pattern that supports solving current problems. Then it was found that one group received information sources from outside the school, it was revealed by K10 who stated

"... I was once asked by my neighbor to justify the wifi in his house..."(K10)

The research subject from K10 independently searched for information through the internet how to improve the existing network in his neighbor's house. Thus, the information he got before became a provision of experience in solving problems in case studies.

In the ability to conclude problem solving, 8 groups can provide answers and explanations about how research subjects respond, consider, and self-reflect when facing problems in case studies. Although the answers of the research subjects are long, the key points conveyed in their sentences will be outlined. The first K2, K6 and K10 reveal that in solving problems it is necessary to map the concept of problem solving, as follows

"... We can solve a problem that we find better if we make a series of solutions" (K10).

Then K1, K2, K5, K7 and K9 revealed that in solving problems the importance of strengthening literacy, as mentioned by K5

"... the importance of digging as deep into information as possible" (K5).

Then there are 2 groups, namely K7 and K9 who claim to consider the problem, as expressed by K7

"... more considered if there is a problem of unknown problems from the beginning" (K9).

Then K1, K3 and K10 in their conclusions explain the anticipatory steps and anticipatory activities that need to be carried out, as expressed below

"... if we do not understand the problem we are facing, we can consult with people who are experts or experienced in it" (K10).

Then there are 4 groups that implicitly reflect their knowledge after they solve the problem, namely K3, K5, K7 and K9. K9 states

"... so in conclusion we can learn and know how to install correctly, from how to install what tools are used, how to connect from the ISP's office to our homes and also we also know where the ISP gets the internet from" (K9).

The research subjects are able to transfer knowledge and identify patterns and relationships between the information obtained to solve problems in case studies. They draw on knowledge of network peripherals and devices, as well as previous experience in configuring and troubleshooting networks to address issues in case studies. The ability to identify and find similar patterns in this section is also explained by Wing (2006) in his article.

Incremental Iterative Thinking

In the ability to develop design plans, especially in overcoming problems with network devices that cannot access the network wirelessly such as printers and computers contained in this case study question can be answered by all groups of research subjects, the answers they give are in the form of solutions to add network devices as follows

"... can be given a solution by using a UTP cable to connect a router or modem with a computer" (K1),

In addition, other groups also mention UTP cables, Wifi adapters, LAN cards. Then if there is a printer that must be connected to the network available at the client's home, k4 reveals

"... if the printer can use a LAN cable" (K4).

In addition to providing additional network devices to provide solutions for printers and computers to access the network, answers from K7 contain verbs or sentences that mean to perform an action

"... We can crimping the utp cable and connect it to the computer to the modem pack, then we configure the modem" (K7).

Furthermore, in the ability to identify project concepts, there were 9 groups who answered interview questions. When the research subjects explained how the ISP concept provides internet connection to the actor's house in the case study, there were three important points explained by the research subject. The first point is how ISPs get internet access, there are 5 groups, namely K1, K2, K3, K7 and K9 which explain how ISPs get internet access which will later be channeled to the client's home, one of the answers from students

"... ISPs get internet first from Indonesia Data Center, yes" (K2).

The second point is how ISPs distribute internet access, there are 7 groups that explain how ISPs distribute internet access to client homes, namely groups 1, 2, 3, 5, 6, 7, and K9 which reveal

"... from the branch office he will send another signal using fiber optic cable but a smaller one, so it is sent from his branch office and then to the pole installed on the side of the road after that it can only enter the client's house" (K9).

Then the third point is how the client receives internet access from the ISP, from these seven groups explain technically how the internet can reach the client's home and also explain how the access point, router, or modem transmits internet signals in the client's home, one group explained

"... captured by a device in the form of a modem then after being configured it will provide an internet signal in the form of wireless will be captured by devices in Marco's house "(K6).

On the ability to implement the design design, 9 groups were able to answer and explain questions about planning and implementing network installations. They started by making an implementation schedule, which was referred to by 5 groups as the initial stage of implementing the design design, one of which was k1 mentioned

"... first make a schedule in advance so that the homeowner is ready when I have surveyed so that our homeowner can ask questions" (K1),

This is done so that research subjects get the right time when implementing the design they have made. Then the second point is to conduct a field survey, K2 mentions

"... conduct a site survey for cable removal, continue to survey the customer's place on whether it is safe to pass through the cable or not" (K2).

Then the next point is confirmation with the client as explained by K2 is:

"... make a clear appointment with the homeowner and then we coordinate the installation of the access point where it will be placed" (K2)

This is done to facilitate the flow of cabling and adjustment to outdoor conditions. Then the fourth point is to carry out a field action plan

"... the cable installation is a fo cable to the server, so at home it goes directly to the server and the fiber optic cable we will cross, we propagate it through the existing pole pole to the server location" (K1)

From the statement given by K1 the description of network installations in the field, especially outdoor, cable installation is stretched through the available poles. Then for the last point is to configure the end point. K10 describes what they will configure with the statement

"... the main one is the first IP and then also the firewall which will be used to connect the router to the ISP Internet events can be channeled well" (K10).

The research subjects were able to overcome the case of devices without peripherals for internet access by adding LAN cards, wifi adapters, and LAN cables. They can also explain the concept of ISPs and how the internet is delivered to clients' homes. In implementing the design, they are able to provide detailed stories about the activities to be carried out.

Modularizing

There were 8 groups that could provide answers in the ability to combine information by research subjects, but only 7 groups could explain that the information they found supported each other to solve the problem in the case study. Information about the type of network device and field conditions is the most combined by the research subjects, there are 3 groups namely K2, K5 and K7, one of which reveals

"... This case will only install internet in marco's house so it is only one purpose and this can use a single mode FO cable pack" (K7),

K7 adjusted to the case study presented where there was only one house that needed internet access and K7 found the type of cable solution needed according to the circumstances of the case study. Then the information combined by K9 is the installation of network devices and the configuration of network devices, the group said

"... combining information about cabling we can help marco how the internet got to marco's house and information about the configuration of the router"(K9),

The sentence conveyed by K9 has an incorrect meaning, but the purpose of this K9 from information about cable installation and router configuration can be combined to solve problems in case studies. Then the information combined by K2 is information about field conditions and device needs, K9 mentions

"... combine the information i.e. distance and cable used kayak distance from my house to ISP four kilometers" (K9)

from knowing about the distance between the ISP's home and office to the required cable length, both pieces of information are combined into a solution to find out the required cable length. Then K6 combines information about device specifications and client needs

"... so that the internet can be connected with fast data transmission speeds, namely by using a single mode FO cable because this cable can transmit data better than other cables" (K6)

in the first sentence delivered by K6 concludes about the need for fast data transmission speeds and information about the right cable specifications to meet these needs. Then the information combined by K1 is information about field conditions and SOPs that state

"... information about the cable installation route from the server to marco's house and also about work safety SOPs" (K1)

It is understood that the work safety SOPs needed and used can adjust to field conditions or cable installation routes.

Evaluation of this ability found that most research subjects can combine two or more of the information they get and use it to build solutions to solve the problems they encounter..

Reusing and Remixing

Questions are asked and confirmed to the research subjects regarding the efficient use of time to solve problems in case studies. In conclusion, all research subjects were able to solve the problem in 4 hours or less, indicating that the time given was more than enough because there was only 5 hours available for data collection at the study site. Interviews were conducted one by one research subjects and found the answers from them were

"... very enough sir" (K1).

Research subjects efficiently complete network design tasks before time runs out and provide correct solutions related to network design drawings, including device sequences, descriptions, and IP configurations. They can give good answers even while completing case studies.

Testing and Debugging

There were 8 groups of respondents, all of whom could plan anticipatory actions to prevent possible problems from occurring. Work accidents are the most frequently mentioned problem, and recommended anticipatory steps include the use of complete PPE and network installation in accordance with SOPs. Two groups expressed anticipation by adding personnel and coordination of technicians to prevent work accidents, this was conveyed as follows

"... In installation, there must be one person who accompanies for example, the ladder is held with his friend below" (K1).

6 groups plan to address device breakdowns, focusing on fiber optic cables that are often damaged due to failed connection, cuts or breaks. Three groups suggested carrying a network toolkit to repair damaged cables, while the other three groups brought backup devices. One group anticipates by anticipating mobilization, it is conveyed as follows

"... when bringing the FO cable to the location make sure it is not folded" (K5).

3 groups plan weather conditions and anticipate by looking for weather information in advance. 2 groups plan for failed configuration problems and anticipate with repeated configurations. K7 plans for the problem of lack of network devices and anticipates it by bringing additional devices or backups. K9 plans for problems such as improper cable placement and does not pay attention to the risks faced by stating

"... it could be that later the cable is hit by a high vehicle or when if the cable for example is in a tree, if for example there is a storm it can break" (K9).

K9 provides anticipatory steps solutions by conducting site surveys in advance so that cable installation planning can be conditioned safely.

Then in the ability to develop problem-solving strategies, research subjects succeeded in answering questions about the ability to develop problem-solving strategies. A total of 8 groups answered "extracting information from other sources" as the main strategy. Other groups include evaluating progress, motivating themselves, and adding personnel to assist network installations in the field.

The conclusions obtained from the ability of testing and debugging in general the research subjects are able to anticipate and plan risks in the design and implementation of the network by including anticipatory steps to overcome these risks. They also develop problem-solving strategies by extracting information from reliable sources and motivating themselves and evaluating progress.

CONCLUSION

Based on the results of research on computational thinking analysis of students in designing ISP kite structures for homes, it can be concluded that the ability to understand, analyze and solve problems in general can be said to be good, but there are still shortcomings such as less detailed explanations and cannot convey what is in their minds properly, this happens because this study was carried out suddenly without being noticed by learners and data collection conducted using concurrent think aloud. So students do not have any preparation to solve the problems in the research case study and answer every interview question when they complete the case study. Assessment as learning helps students answer interview questions, because they have to think hard to convey how they use their thinking to understand problems and analyze information. It can be concluded that assessment as learning can help them by reflecting on themselves and understanding the thought process they experience to answer interview questions and complete case studies.

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