

Educators' Perception of the Utilization of Information and Communication Technology (ICT) in Chemistry Learning

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Abstract: The use of ICT in education in the 21st century has facilitated educators to make changes in learning, so that learning becomes challenging and fun. This study aims to describe the perception of teachers regarding the use of information and communication technology in chemistry learning. For this purpose, a survey was conducted to collect data from 20 teachers in Sintang and its surrounding areas. The method used is the descriptive method. The teachers' perception questionnaire on ICT in chemistry learning was adopted from *Teachers' perception towards ICT in the teaching-learning process: Scale validity and reliability study* were translated into Indonesian and modified to suit the conditions of the school. The results showed that the average perception of educators on the use of ICT in chemistry learning was 78,91 with a "Good" category, it is known that the use of ICT in chemistry learning is still not implemented for all educators.

Keywords: Chemistry learning; Educators' Perception; ICT

Introduction

Technological developments in the 21st century have affected all aspects of people's lives. Digital technology which began with the invention of the internet and computers is now growing. The needs and lifestyle of the community will be affected by the development of technology (Rizal et al., 2019). People need skills in utilizing information technology in order to adapt and be able to compete. The 21st century does not only require people to be skilled in information technology, but communication technology skills also really need to be owned by the community. Direct face-to-face communication is no longer limited by distance, time, and space today (Zamroni, 2009). Different cities or countries do not limit users to face-to-face because video call communication media is available. The existence of social media as a communication medium also makes it easier for users to express creative ideas, become an online discussion forum, and share experiences.

Skills in utilizing Information and Communication Technology (ICT) are often referred to as digital literacy.

Digital literacy is a person's interest, attitude, and ability to use ICT for life activities related to data or information, building new knowledge, communicating effectively in society (Setyaningsih et al., 2019). ICT or Information and Communication Technologies (ICT) is hardware and software for all activities related to processing, manipulating, managing, and transferring or transferring information between media (Herlinda et al., 2020).

The students faced by educators in the 21st century are students who belong to the millennial generation. This generation is less interested in learning if they only receive or hear all information from educators without going through information and communication technology. Students prefer to use information technology in all activities at school. The emergence of the digital native phenomenon also requires educators to be skilled in utilizing information technology in learning (Mawarni et al., 2021). Information and communication technology facilitates educators to create challenging and fun learning, so that learning does not take place monotonously and students can be

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active in learning (Frydrychova Klimova & Poulova, 2014).

Chemistry learning is one of the subjects that are less liked and difficult for students to learn. The material for reaction equations, atomic concepts, and oxidation numbers are examples of chemical material that are abstract and difficult for students to learn (Dinatha, 2018). Thus the use of ICT in chemistry learning can help students learn abstract chemistry. The reality in schools is that there are still many educators who are constrained in using ICT to assist in learning. ICT in chemistry learning can make the material delivered by educators more creative (Rizaldi & Yana, 2022), so that it is easier to understand (Dinatha, 2018).

The results of previous research studies found that out of 2.7 teachers in Indonesia, only 10% to 15% of teachers used technology for learning in schools (Rahim et al., 2019). There are several supporting factors that influence educators in utilizing ICT in learning, including the perception factor. Perception is the experience of an object, event or relationship that is obtained by a person by inferring information and interpreting messages (Rakhmat, 2015). A person's perception of the same thing can be different from another if the information received from the surrounding environment is different. Perception is the process of receiving information or stimuli from the environment around the environment, then interpreting the information and categorizing it within the framework of knowledge appropriately (Mahdum et al., 2019). In addition, the perception of educators is a factor in the implementation of ICT learning to increase superior human resources so that they can compete in the era of globalization (Rozie, 2018). Thus, the educator's perception of the use of ICT in chemistry learning is the inference or interpretation of educator information based on the experience of educators participating in training or using ICT to teach chemistry.

The results of the study on the effect of teachers' perceptions on the use of ICT in science learning in SMA/MA in Gerung District concluded that there was a positive and significant relationship between teachers' perceptions of ICT and the use of ICT in learning (Hidayati et al., 2021). It means that the higher the teacher's perception of ICT, the higher the use of ICT by teachers in learning. Furthermore, research conducted by Kazu et al. (2020) found that perceptions of kindergarten are related to the frequency of computer and internet use. The more often a person works using computers and the internet, the better his perception of ICT will be. Prospective teachers who utilize ICT in all their activities, both inside and outside the classroom will determine the level of digital literacy of the prospective teacher (Çam & Kiyici, 2017). For this reason, as an effort to develop digital literacy among

educators and support previous research that has been carried out, it is necessary to conduct research on educators in high school or equivalent in Sintang and its surroundings to find out educators' perceptions of ICT in chemistry learning. This study aims to explore educators' perceptions of the use of ICT in chemistry learning. At the same time, the results of this study can be used by schools and related agencies as a reference in developing educators' digital literacy.

Method

This study used a descriptive method with the research sample determined using purposive sampling technique on the entire population of high school chemistry educators in Sintang and its surroundings so that 20 questionnaires were filled in entirely by educators. The research instruments used in the study consisted of the main research instruments and supporting research instruments. The main research instrument is a questionnaire on educators' perceptions of ICT in chemistry learning given to teachers in FGD activities in Sintang District. The instrument was adopted from Assessing Teachers' Perception on Integrating ICT in Teaching-Learning Process: The Case of Adwa College (2015) and translated into Indonesian and modified to suit the conditions of the school being studied. In full, the teacher perception questionnaire grid can be seen in Table 1.

Table 1. Grid of Educators' Perceptions of Utilization ICT in Chemistry Learning

Dimensions	Item Number
Cognitive	1 and 11
Affective	2, 5, 6, 7, 8, 9, and 10
Conative	3 and 4

The test results of the educator's perception questionnaire using the Alpha Cronbach formula to measure the internal consistency of the instrument obtained 0.709 higher than 0.700, meaning that the questionnaire is feasible to use for instrument research. Supporting research instruments are interview guidelines, observation sheets, and documentation. The data from this supporting instrument were used to complete the data from the perception questionnaire as well as to clarify the data. Data analysis techniques to determine the level of perception of educators are calculated using the formula:

$$P = \frac{f}{N} \times 100\% \quad (1)$$

Information: f = Frequency of respondents' answers, N = Number of cases (number of frequency or number of

individuals), and P = Percentage number (Sari et al., 2019)

Analysis of the data from the questionnaire results are grouped by categories as follows (Febrialismanto & Hukmi, 2018):

Table 2. Categories of Teachers' Perceptions of the Utilization of ICT

Range (%)	Categories
>80	High
>60 - <80	Fairly High
>40 - <60	Low
<40	Very Low

Result and Discussion

Results

Analysis of the data on the results of the questionnaire on the perception of educators on the use of ICT in chemistry learning given to 20 respondents, obtained an average perception of educators of 78.91% with a fairly high category. This shows that educators respond positively to technological developments and realize the importance of using ICT in learning (Singh & Chan, 2014). The positive response of this educator is

also related to the training that has been obtained by the educator. The types of training related to ICT that have been attended by educators, namely: basic computer skills, searching for information on the internet, making presentation materials using Power Point, designing ICT-based learning media, ICT-based evaluation tools, and online-based teaching materials. ICT training programs can improve teacher competence in using computers (Uslu, 2012). The results of the questionnaire data on training activities that have been followed by chemistry educators in full can be seen in Table 3.

Table 3. Training Activities Attended by Chemistry Educators

Training	Amount	%
Basic Computer Skills	10	50
Searching for Information on the Internet	11	55
Making PPT presentation materials	10	50
Designing ICT-Based Learning Media	20	100
Designing an ICT-Based Evaluation Tool	20	100
Designing Online-Based Teaching Materials	19	95

Educators' perceptions of the use of ICT in chemistry learning are in Table 4.

Table 4. Educators' Perceptions of the Use of ICT in Chemistry Learning

Respondent	Item											Total	%	Category
	1	2	3	4	5	6	7	8	9	10	11			
1	5	5	5	4	4	4	4	4	3	5	4	47	85.45	High
2	4	4	4	5	4	5	4	4	4	4	4	46	83.64	High
3	4	4	4	3	3	3	4	5	4	4	4	42	76.36	Fairly High
4	4	4	4	3	4	4	4	4	4	4	4	43	78.18	Fairly High
5	3	4	3	4	4	4	4	3	4	4	4	43	78.18	Fairly High
6	4	4	4	3	4	3	4	4	4	4	4	42	76.36	Fairly High
7	4	4	4	4	4	4	4	4	4	3	3	42	76.36	Fairly High
8	4	4	4	4	4	4	5	4	4	3	3	43	78.18	Fairly High
9	4	4	4	4	4	4	4	4	4	3	3	42	76.36	Fairly High
10	4	4	4	4	4	3	4	4	4	4	4	43	78.18	Fairly High
11	4	3	4	3	3	4	4	4	4	3	3	39	70.91	Fairly High
12	4	4	4	4	4	4	3	4	4	4	4	43	78.18	Fairly High
13	4	4	5	4	4	3	4	4	3	4	4	43	78.18	Fairly High
14	4	4	5	4	4	4	4	3	4	4	4	44	80.00	High
15	4	4	4	4	4	5	5	4	4	3	3	44	80.00	High
16	3	4	4	4	4	4	4	4	4	3	4	42	76.36	Fairly High
17	3	4	3	4	3	4	4	4	4	4	4	41	74.55	Fairly High
18	3	4	4	4	4	4	4	3	4	3	3	40	72.73	Fairly High
19	4	4	4	4	4	4	4	4	4	4	4	44	80.00	High
20	4	4	4	4	4	4	4	4	4	4	4	44	80.00	High
Average													77.91	Fairly High

Discussion

The results obtained from the questionnaire on the average perception of educators on the use of ICT in chemistry learning are 77.91% in the high enough category with details as much as 25% in the high category and 75% in the moderately high category as

shown in Table 3. These results indicate that educators conclude from experience that the use of ICT in learning is very helpful in explaining conceptual chemistry, so that students find it easy to learn chemistry. Furthermore, if we look at the dimensions of the perception of chemistry educators on the use of ICT in

learning, it is found that the average dimensions of perception, namely: cognitive, affective, and conative are in the same category, which is a fairly high category as shown in Figure 1.

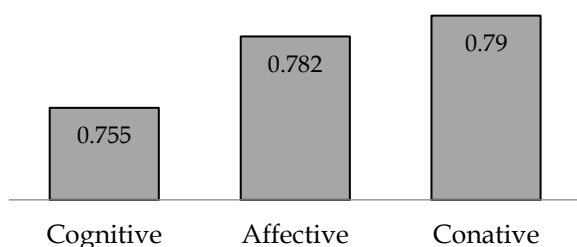


Figure 1. Average perception based on perception dimension

Based on Figure 2, it shows that the number of educators who responded in the high category was 1 (5%) educators, 15 (75%) educators were high enough, 4 (20%) low and 0 (0%) very low educators. These results illustrate that educators have a fairly high perception of the use of ICT rather than printed materials for learning purposes, which is the most widely compared to other categories. For conceptual understanding, theories, and formulas that build in-depth understanding cannot be described systematically and sustainably, educators will find it difficult if only print media is used (Dinatha, 2018).

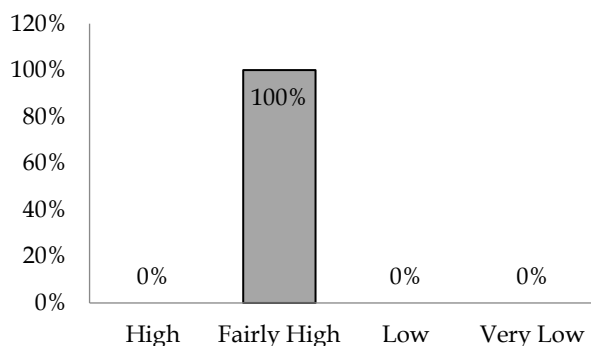


Figure 2. Item "Use of ICT is more important than printed materials for learning purposes"

The results of interviews with chemistry educators found that the printed materials commonly used were material summaries, handouts, and modules. However, to explain in depth and easy for students to understand, ICT-based media are used, for example learning videos in teaching the chemical material of the alkaline group elements whose material is not enough just to memorize, but a thought process is needed to understand it. Elemental chemistry is not only a definition but also many abstract concepts that are studied in the material (Arham & Dwiningsih, 2016).

The use of ICT in learning makes it easier for educators to deliver chemistry, which is mostly abstract (Dwiningsih et al., 2018). Learning that only uses printed materials without being accompanied by ICT-based learning media will make it difficult to achieve the learning objectives to be achieved in this material. The technological capabilities possessed by educators will be a very effective and efficient to be used as a support in learning.

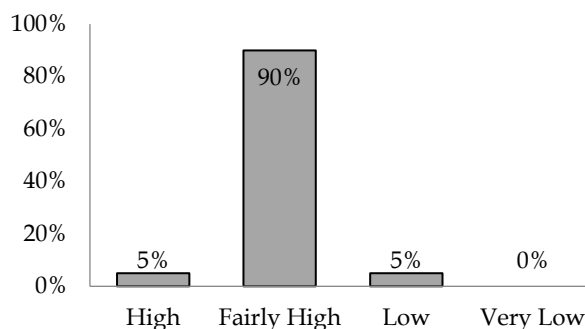


Figure 3. Item "ICT can have a big impact towards learning"

Figure 3 shows that there are 1 (5%) educators in the high category, 18 (90%) in the moderately high category, and 1 (5%) in the low category. It is seen that there are no educators who have a very low perception category. This shows that educators respond positively to the large impact on changes in learning after using ICT. ICT changes attitudes and understanding as well as student learning outcomes in learning chemistry. Supported by several research results show that the use of ICT has a positive impact on learning. Creating a positive attitude in learning chemistry by utilizing ICT such as computers, internet, websites, and projectors using ICT (Agrahari & Singh, 2013). Furthermore, the results of the study also show that ICT makes it easier for students to understand chemical material according to the competencies to be achieved and provides innovation in learning (Jannah et al., 2022).

The results of the interviews also show that educators in learning they prefer to use power point slides which are varied with flash and video, because it makes it easier for educators to teach abstract chemistry material. Furthermore, from interviews, it was also found that students were helped by the existence of these learning media, because it made it easier to understand the concepts being studied. It is proven that there are differences in learning outcomes before and after using flash media in teaching chemical bonds. Students also show positive attitudes in learning, such as being enthusiastic and active in responding to learning. The use of macromedia flash -based learning media in chemistry learning provides experience and understanding to students in identifying and analyzing

abstract chemical concepts and can reduce boredom (Darwis et al., 2020). This is what causes educators to have a good perception that ICT has a big impact on learning.

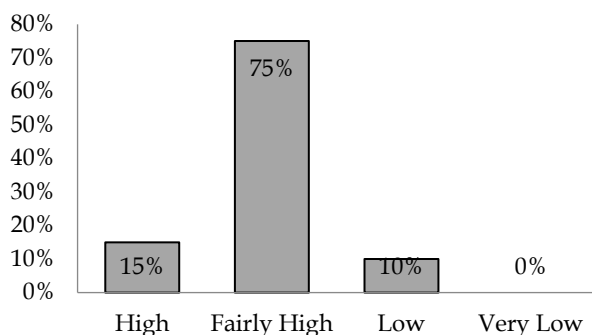


Figure 4. Item "ICT provides awareness of use opportunities technology in learning"

Figure 4 shows as much as 3 (15%) educators are in the high category, 18 (75%) educators are categorized as high enough, and 2 (10%) educators are in the low category. These results indicate that in general educators have felt the benefits of using ICT, although there are still two educators whose perceptions are in the low category. This happens because educators realize that the way students learn in the 21st century is different. The development of science and technology in the 21st century must be anticipated by educators to adapt to the learning being carried out. The learning styles of students are different, they prefer to work and learn using technology, so the learning activities carried out must change. The design of learning activities must be in line with the development of science and technology (Nurdyansyah & Riananda, 2016). Learning in the 21st century is more integrated with knowledge, skills, and mastery in technology and information (Mardiyah et al., 2021). Schools are required to follow this development so that students get optimal services in the learning process.

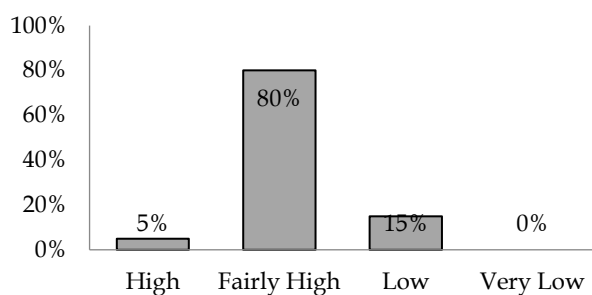


Figure 5. Item "I am interested in using ict in learning activities be more effective"

The results of the questionnaire data analysis "I am interested in using ICT in classroom activities to make it

more effective" as shown in Figure 5 above, obtained as many as 3 (15%) educators with a sufficient category perception and as many as 16 (80%) educators with a fairly high category perception, and 1 (5%) educator with a high category perception. The perception of educators in the fairly high and high category means that learning chemistry using ICT is proven to make it easier for educators to deliver chemistry material. Chemistry is a difficult and abstract subject that is felt by students. For this reason, educators must be able to change the way they teach in implementation of learning, so that students are more interested in learning chemistry (Pongkendek & Marpaung, 2020). The results of research on the use of information and communication technology in learning chemistry conducted by Putra (2017) concluded that ICT-based learning (Information and Communication Technology) can increase students' motivation to learn chemistry. This is what makes educators interested in using ICT in learning.

The results of interviews with educators who have a low category perception obtained information that schools have conducted training activities for educators to improve the competence of educators in the use of technology in learning. They are interested in using ICT in learning, but in the implementation in the classroom they sometimes experience problems, due to the limited means of supporting learning and the skills they have. ICT is sometimes not well facilitated by all schools, limited time for educators to implement ICT, and learning training using ICT for educators and knowledge about management of ICT use in the classroom is still lacking (Nikolopoulou & Gialamas, 2016). This is the reason for the perception of educators in the low category as many as 3 educators.

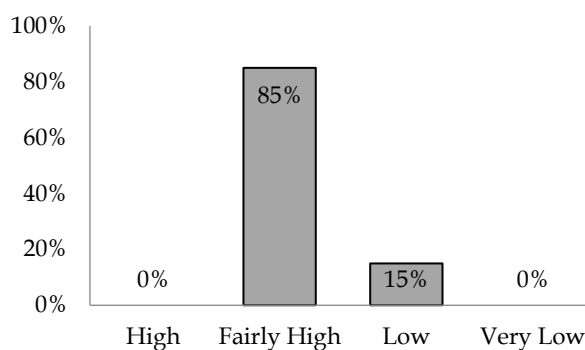


Figure 6. Item "ICT-supported learning can make more effective learning"

Analysis of the questionnaire data as shown in Figure 6 above shows that the perception of educators in the low category is 3 (15%) educators, the category is quite high as many as 17 (85%) educators. These results are supported by the opinion that the use of ICT as a

source and learning media allows to overcome obstacles in the communication process between educators and students, so that the learning process will be more effective (Miftah & Rokhman, 2022; Susilo & Rohman, 2019). The implementation of ICT in learning can assist educators in improving the quality of the learning process, so that learning can take place effectively and efficiently (Huda, 2020).

Chemistry learning becomes more effective if using ICT because educators will easily display formulas, symbols, structures, molecular shapes, understanding a concept and its application. Interviews with chemistry educators obtained information that there are changes that occur in learning when ICT is used. Students' understanding of the subject matter becomes deep when using ICT. For example, in teaching chemical bonds, flash media is used to explain the process of ionic and covalent bonds. The delivery of this material by educators becomes easier and students' understanding becomes better, so that learning objectives are achieved.

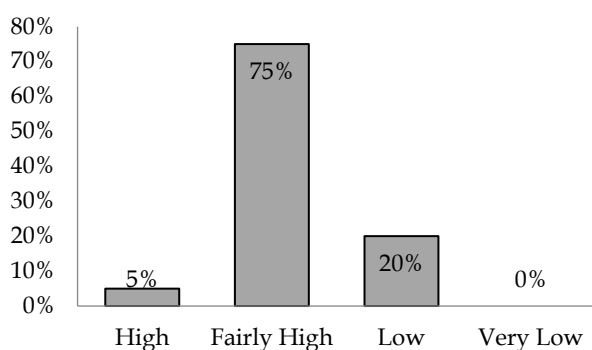


Figure 7. Item "The use of ICT as a learning tool can increase student interest in learning"

Figure 7 above shows that as many as 4 (20%) educators are in the low category, 15 (75%) educators are in the moderately high category, and 1 (5%) educators are in the high category with the perception "using ICT as a learning tool can increase student interest in learning". These results are supported by the opinion that students who learn without interest will find it difficult to master the lesson, even students can be indifferent to the lesson (Baharun, 2015). Furthermore, the results of the study showed that the learning process using ICT-based media (macromedia flash), there was an increase in student learning interest in chemical bonding material (Sormin & Daeli, 2018). So the perception of educators is relevant to the results of previous research.

Utilization of ICT such as computers, internet, websites, projectors can motivate students in learning, so that a positive attitude in learning chemistry can be generated to students (Agrahari & Singh, 2013). It is important to increase the interest of students in learning

chemistry because there is an assumption that chemistry is a difficult subject to understand. This fact spurs educators to exert all their abilities and creativity in making something interesting, so that learning chemistry becomes fun. The chemistry learning process is fun by integrating ICT in learning, for example by watching interesting slides, virtual practicums and showing interesting videos related to chemistry learning (Yusuf, 2017).

Motivation is one of the important factors in learning, because motivation increase interest and desire to achieve goals (Frydrychova Klimova & Poulova, 2014). Learning that is felt less fun can cause students to be less interested in participating in the learning process. If interest in learning increases, students actively try to find out more about chemistry. Thus, the students' mastery of the material increases. ICT-based learning is one of the efforts that educators can make to make changes or improvements in learning. This is what causes chemistry educators in Sintang to respond quite high as much as 75% and as high as 5% to the perception "the use of ICT as a learning tool can increase students' interest in learning".

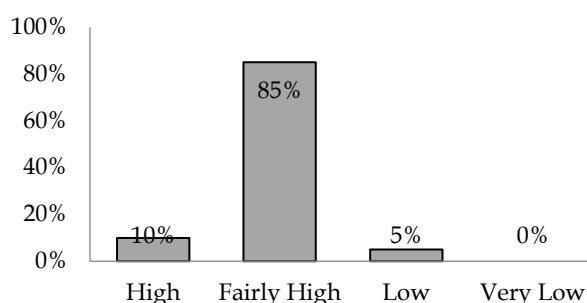


Figure 8. Item "Students can actively master knowledge if ict is integrated in curriculum"

The results of the questionnaire data analysis in Figure 8 show that the perceptions of educators are 5% in the low category, 85% in the moderately high category, and 10% in the very high category. The perception of educators in the fairly high category and the high category with a fairly large percentage is relevant to the demands of the 2013 curriculum policy. Integrated learning with ICT is a must in the 2013 curriculum, meaning that educators must be able to use ICT-based media in learning (Herlinda et al., 2020).

ICT is integrated in the curriculum in schools, so that contextual learning will be easy for educators to do. Chemical concepts that have macroscopic, microscopic and symbolic characteristics become easier to learn by showing the contextual phenomena of the concept. Chemistry educators will find it easy to explain the concept of acid-base macroscopically through the contextual phenomenon of acid rain using ICT. Media

ICT can be used to realize a contextual learning process. Process contextual learning can increase the level of understanding students have been proven, students become more active in trying to understand the material and connect with their experiences (Kristini, 2020). Thus, ICT can make students active in mastering knowledge.

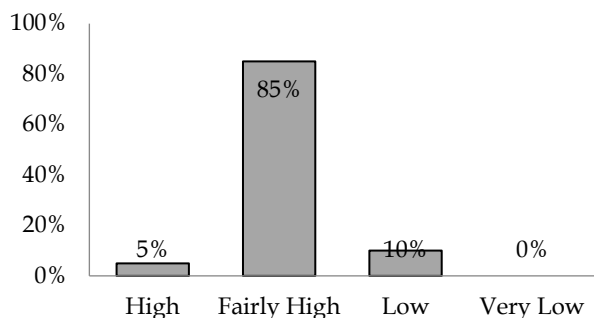


Figure 9. Item "Use of ICT can improve quality learning"

Based on the analysis of the questionnaire data as shown in Figure 9, it was found that the perception of educators "using ICT can improve the quality of learning" was 1 (5%) educators in the high category, 17 (85%) educators in the moderately high category, and 2 (10%) with low category. This finding shows that the perception of educators about the use of ICT can improve the quality of learning is already good. This is also in line with the results of interviews with students that information is obtained that learning chemistry is fun and easy to understand if learning uses videos or the internet. The results of research on the perception and implementation of information and communication technology policies as a means of learning and their influence on the quality of learning are concluded that it is proven that the use of ICT in learning can improve the quality of education (Sinaga & Zainuddin, 2013). ICT can be used in education to make it easier to produce quality human resources (Mardhiyah et al., 2021).

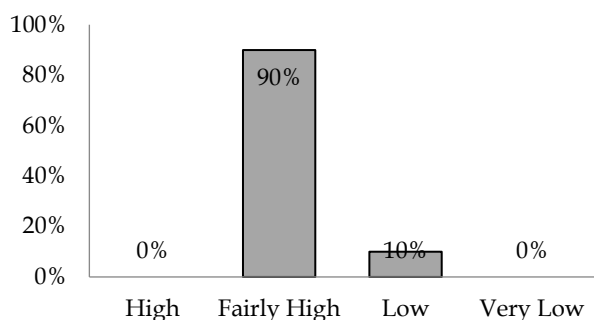


Figure 10. Item "The use of ICT makes it easier for educators to prepare subject matter (assignments, handouts etc)"

Data analysis of the educator's perception questionnaire item 10 "the use of ICT makes it easier for

educators to prepare subject matter" as shown in Figure 9, the results show that as many as 18 (90%) educators have a fairly high perception and 2 (10%) educators have a low perception. These results indicate that the interpretation and experience of chemistry educators on the use of ICT is good, because it makes it easier for educators to prepare subject matter. Many interesting chemistry materials are available on the internet and can be accessed by educators according to their needs. Chemical experiments that are difficult to carry out in the laboratory due to equipment and material constraints can be carried out through computer programs (Jannah et al., 2022). Educators become easier and faster in finding literature or information related to the material being taught, and implementing learning is more interesting using concrete examples through image shows, videos, and power points (Mukaromah, 2020; Susilo & Rohman, 2019). Thus ICT can help educators to prepare subject matter.

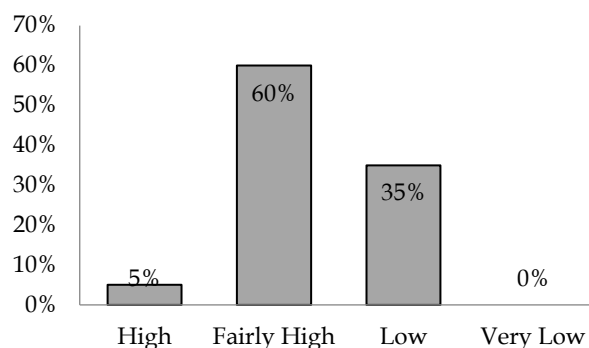


Figure 11. Item "Use of ICT makes educators more productive in presenting learning"

The perception of educators based on Figure 11 above shows that as many as 1 (5%) educators have a high perception, 12 (60%) educators have a fairly high perception, and 7 (35%) educators have a low perception on the item "using ICT makes educators more productive." Mastery of ICT helps educators in making various innovative learning products needed to produce quality students. This is important because the demand for learning in the 21st century is to generate resources quality, superior, and competitive human beings, not just teaching regarding knowledge, but skills are an important part of improve human resources (Mardhiyah et al., 2021).

Based learning media in learning makes a major contribution and innovation to the world of education. Educators become more innovative and productive in presenting subject matter when using ICT. It is very easy for educators to improve their teaching abilities, because finding literature and information related to the material to be presented in learning activities is very easy through ICT. (Susilo & Rohman, 2019). Thus, through ICT, the

productivity of educators in presenting material will increase. The results of interviews with several educators obtained information that the use of ICT as a support for learning has only been used in the last semester. This causes the productivity of educators in presenting learning has not been felt by educators.

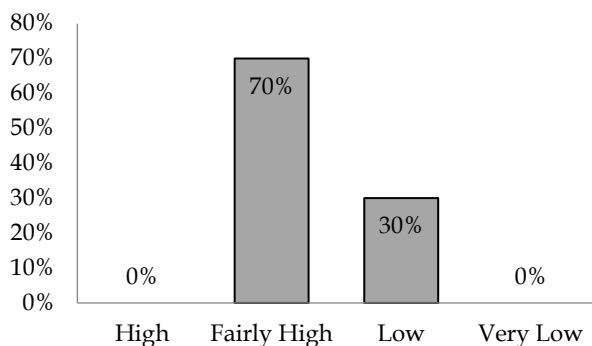


Figure 12. Item “The use of ICT makes it easy to achieving advanced human resources”

Figure 12 above shows the perception of educators in the fairly high category as many as 14 (70%) educators and low category educators as many as 6 (30%) educators. Based on these results, it is known that educators have good perceptions regarding the use of ICT which can make it easier to reach resources advanced human. The use of ICT in education can improve human resources resulting in the advancement of the welfare of a country (Cholik, 2021). Interviews with educators who have a low category perception obtained information that the use of ICT is still only used in chemistry learning, so it has not seen significant progress from students caused by the use of ICT. Interviews with educators who have low category perceptions obtained information that the use of ICT is still new in chemistry learning so significant progress had not been seen from the students due to the use of ICT. However, this does not mean that the potential of using technology in chemistry learning has been ignored or considered ineffective. With the proper steps, integrating ICT can be a powerful tool to enhance learning and advance learners' understanding of complex chemistry concepts. That is by Hudayati et al. (2021) stated that if teachers have a positive perspective of ICT then implementation in the classroom will be carried out as expected, and motivation from the surrounding environment that uses ICT in its learning can influence the utilization of ICT by educators. Although a significant impact may not seem at the beginning of use, the processes of developing and applying technology in learning should considered as an investment for the future, where the best results in chemistry learning can be reached through the use of technology in innovative and effective ways.

Conclusion

The results of the study can be concluded that the average perception of educators on the use of ICT is 78.91 with a good category, so it is known that the use of ICT in chemistry learning is still not implemented for all educators.

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Author Contributions

The main author contributed to designing research, conducting research, collecting and analysing data, writing research articles. The second, third, and fourth author played a role in validating, collecting and analysing data, reviewing, and editing this articles until published.

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Conflicts of Interest

The authors declare no conflict of interest.

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