

New Design of Interactive Academic Supervision Using the Waterfall Method to Improve Teachers' Pedagogical Competence

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ABSTRAK

Salah satu strategi untuk meningkatkan kompetensi pedagogik seorang guru dapat kepala sekolah melalui supervisi akademik, namun selama ini pelaksanaannya mengalami banyak kendala sehingga kurang berhasil dalam meningkatkan kompetensi pedagogik guru. Tujuan dari penelitian ini adalah mengembangkan desain baru supervisi akademik interaktif dengan metode waterfall dalam Upaya meningkatkan kompetensi pedagogik guru. Jenis penelitian ini adalah Research and Development (R&D) dengan menggunakan model ADDIE dengan pendekatan Mixed Method (sequential exploratory). Subyek penelitian meliputi kepala sekolah, wakil kepala sekolah bidang kurikulum, dan guru. Teknik pengumpulan data melalui wawancara, studi dokumentasi, observasi, FDG dan kuesioner. Instrumen pengumpulan data berupa kuesioner. Teknik analisis data yang digunakan dalam penelitian ini yaitu analisis deskriptif kualitatif dan deskriptif kuantitatif. Hasil penelitian yaitu penelitian ini menghasilkan model dan panduan supervisi akademik berbasis waterfall dengan nama SUPER WATER. Hasil validasi produk oleh ahli supervisi sebesar 88% ahli IT sebesar 94 % dengan kategori sangat tinggi. Hasil uji coba oleh kepala sekolah sebesar 91 % dan lima guru sebesar 91%,. Disimpulkan bahwa produk ini layak untuk digunakan. Implikasi penelitian ini yaitu Waterfall menjadi alternatif teknologi yang dapat digunakan untuk mengatasi permasalahan yang muncul pada saat ini.

ABSTRACT

One strategy for increasing a teacher's pedagogical competence is through academic supervision. However, its implementation has experienced many obstacles, so it has yet to improve teachers' pedagogical competence successfully. This research aims to develop a new design for interactive academic supervision using the waterfall method to improve teacher pedagogical competence. This type of research is Research and Development (R&D) using the ADDIE model with a Mixed Method (sequential exploratory) approach. Research subjects included school principals, deputy principals for curriculum, and teachers. Data collection techniques were done through interviews, documentation studies, observation, FDG, and questionnaires. The data collection instrument is a questionnaire. The data analysis techniques used in this research are qualitative descriptive analysis and quantitative descriptive analysis. The research results produce a waterfall-based academic supervision model and guide called SUPER WATER. Product validation results by supervision experts were 88%, and IT experts were 94% in the very high category. The test results by the principal were 91%, and five teachers were 91%. It was concluded that this product is suitable for use. This research implies that Waterfall is an alternative technology that can be used to overcome problems that arise at this time.

1. INTRODUCTION

The teacher's competence largely determines the success of learning in the classroom. Teachers are at the forefront of serving and determining students' success. One of the competencies that professional teachers must have is pedagogic competence (Ahmad, 2019; Arqam, 2019; Tyagita & Iriani, 2018). Pedagogical competency is the ability to manage learning, which includes understanding students, designing and implementing learning, evaluating learning outcomes, and developing students to actualize their various competencies (Ambarita & Septiawan, 2019; Rochaendi et al., 2021; Setiyowati & Arifianto, 2020). Previous research findings also confirm that teachers with good pedagogical competence can help

improve student achievement (Aryana et al., 2022; Zulaiha, 2023). Other research also states that there is a positive and significant influence between teacher pedagogical competence and student achievement. The more teacher pedagogical competence increases, the more student achievement will increase (Andini & Supardi, 2018; Supriyono, 2017). Improving the quality of educational services regarding teacher professional qualifications needs to be fostered and reorganized so that, in turn, it can be used to lead teachers to become professional figures in education. Teachers will work professionally and with adequate competence (Ahmad, 2019; Arqam, 2019; Salmawati et al., 2017; Tyagita & Iriani, 2018).

School principals can develop one strategy for improving a teacher's pedagogical competence through academic supervision. Academic supervision is a series of activities that help teachers develop the ability to manage the learning process to achieve learning goals (Saleh et al., 2021; Singerin, 2021). Academic supervision is assessing and developing teachers to improve the learning process's quality so that student competence achieves optimal results (Agustina & Kristiawan, 2020; Mustabsyiroh et al., 2021; Noor et al., 2020). Supervision can be carried out to monitor, assess and improve the learning process. With academic supervision, school principals can improve teachers' pedagogical competence. Previous findings also confirm this, which state that principal supervision positively and significantly influences teacher pedagogical competence (Kartini et al., 2020; Nasution et al., 2021). Academic supervision is an approach in education that aims to improve the quality of learning and student achievement with the help of a supervisor or academic advisor.

The current problem is that many school principals still need help to supervise properly. Previous research findings also confirm that not all school principals can carry out the academic supervision process well and efficiently (Istiningsih et al., 2020; Kartini et al., 2020). Another finding is that there are obstacles for school principals and teachers in implementing supervision, so supervision is less successful in improving teachers' pedagogical competence (Babuta & Rahmat, 2019; Berliani & Wahyuni, 2020). The observations in several schools also found several obstacles, including the time allotted needing to be more appropriate for teachers and supervisors because school principals were busy carrying out other tasks such as sudden meetings, difficulty arranging time for classroom observations, and face-to-face teacher direct coaching. Meanwhile, apart from carrying out the main task of teaching, teachers also have other duties and obligations, such as being field coordinators, homeroom teachers, and committee members; there are unexpected obstacles, such as dealing with students who need help. These obstacles become disturbances beyond the control of a teacher and school principal. These time constraints also cause school principals to experience difficulties monitoring teacher development and a lack of interaction and feedback. The supervision process is done manually to process the results, which takes a long time. This causes supervision results not to be immediately known, and the data collected needs to be stored properly. Manual supervision also faces the obstacles of limited information and less objective assessments.

These obstacles must be resolved so academic supervision can run smoothly without being constrained by time and busyness. The school principal, as supervisor, has a strategic role in improving the quality of education in the institution he leads (Erdianti, 2014; U-Sayee & Adomako, 2021). The school principal is responsible for supervising teachers in learning activities to improve the quality of learning in schools (Adnan et al., 2020; Agustina & Kristiawan, 2020; Mustabsyiroh et al., 2021; Noor et al., 2020). Supervisors are responsible for improving teachers' abilities in managing learning activities in schools and have a very important role in the development and progress of schools (Marwati et al., 2019; Nasution et al., 2021). School principals must conduct supervision well and correctly, using principles and appropriate techniques and approaches. The supervision process requires easy mechanisms and system management for input, process and output to make the results accurate and impactful. This way, the supervision results are quickly known, and feedback and follow-up actions can be determined. One way to improve the quality of supervision is by using technology.

Online academic supervision using web applications can be done flexibly without time and space limitations (Fendi, Hanafi, Monia, et al., 2020; Yussanti & Dwikurnaningsih, 2020). With online academic supervision, school principals and teachers can still supervise while carrying out their main duties and other responsibilities. One online application that can be used is a website created using the waterfall method. The waterfall method is an SDLC model often used in developing information systems or software (Christian & Ariani, 2018; Nur, 2019). This model uses a systematic and sequential approach. The stages in this model start from the planning stage to the management stage (maintenance) and are carried out in stages. Developers need to know more about the system development process and its characteristics when using the waterfall model. The advantage of the waterfall model is that it is easy to understand and simple because the development stages are carried out sequentially. In addition, because each stage must be completed before moving on to the next stage, the waterfall model encourages good documentation and a more structured project management (Christian & Ariani, 2018; Nur, 2019).

Previous research also states that utilizing advances in technology and information makes it possible to develop a more efficient and effective model of academic supervision in the form of academic supervision carried out online (Fendi, et al., 2020; Fendi, Hanafi, Monia, et al., 2020). Other findings also show that online academic supervision can help optimize supervisor services to improve teacher competence (Fendi, Hanafi, M., et al., 2020; Khoeriyah, 2015). Online academic supervision can be a medium to bridge between supervisors and teachers. Communication between supervisors can be done effectively, efficiently, quickly and easily. It was concluded that schools need a new design for interactive academic supervision that can help school principals and teachers implement academic supervision. However, there has yet to be a study regarding the new design of interactive academic supervision using the waterfall method to improve teacher pedagogical competence. The novelty of this research lies in the advantages of the new design of academic supervision, "SUPER WATER," which can provide school principals with facilities for determining supervision mechanisms, accessing data, processing data, analyzing data and determining follow-up actions automatically, as well as direct interaction with teachers through the system. Based on this, this research aims to develop interactive academic supervision using the waterfall method. This research aims to improve teacher pedagogical competence.

2. METHOD

This type of research is research and development with a Mixed Method (sequential exploratory) approach. The development procedure in this research using the ADDIE model includes stages: Analysis, Design, Development, Implementation, and Evaluation (Maxnun et al., 2024; Spatioti et al., 2022). This research was conducted at Satya Wacana Christian High School, Salatiga. At the analysis stage, needs and problems were identified in managing academic supervision at Satya Wacana Christian High School, Salatiga. A new design for interactive academic supervision will be developed at the design stage based on the results of the needs analysis. At the development stage, develop a technology-based method by following the design created in the previous stage. At the implementation stage, the method that had been developed was tested and applied at the Satya Wacana Christian High School, Salatiga. At the evaluation stage, an evaluation was carried out on the effectiveness of the new design of interactive academic supervision using the Waterfall model.

Research subjects included school principals, deputy principals for curriculum, and teachers. The test subjects in this research consisted of 10 teachers who worked at Satya Wacana Christian High School, Salatiga. Product testing in this development research will involve two validators: material experts or content experts with competence in academic supervision and IT experts with special competence in IT— data collection techniques through interviews, documentation studies, observation, FDG and questionnaires. Data collection techniques through interviews will be used in this research to gain in-depth insight from the research subjects, namely the principal, curriculum representatives, and teachers at Satya Wacana Christian High School, Salatiga. Documentation study data collection techniques will be used in this research to collect information and documents related to implementing a new design for interactive academic supervision using the Waterfall model at Satya Wacana Christian High School, Salatiga. Observation techniques will be carried out at Satya Wacana Christian High School, Salatiga, to gain a deeper understanding of the ongoing implementation of academic supervision at the school. FGDs were conducted to obtain information regarding academic supervision, the problems faced, and the approaches and strategies expected in the new design of interactive academic supervision. Questionnaire techniques collect data through direct interaction between researchers and research subjects. The questionnaire used to collect data is a questionnaire sheet. The questionnaire grid used is presented in Table 1 and Table 2.

Table 1. ICT Expert Validation Instrument

No	Rated aspect	Indicator
1	Display quality	Initial view Menu display Color matching in method. Font size and type Menu size Image suitability Use of background
2	Technical quality	Loading speed Ease of operation of the method Method Flexibility

Table 2. Supervision Expert Validation Instrument

No	Rated aspect	Indicator
1	Planning Stage	Observation Plan Review the learning plan Determine the observation target Determine observation techniques
2	Supervision Implementation Stage	Observation of learning implementation Overall observation Take notes and record learning activities and things that happen
3.	Discussion Stage	Provide reinforcement Review the learning objectives Review the observation data Data is saved Summing up Opinion suggestions Formulate no further

The data analysis techniques used in this research are qualitative descriptive analysis and quantitative descriptive analysis. The qualitative analysis processes data from interviews and field observations with school principals, student assistants, STP2K coordinators and home teachers. Miles and Huberman noted that qualitative imaging techniques include data reduction, data display and conclusion. Quantitative analysis is used to process data in the form of assessments carried out by validators or experts and users to determine the feasibility of the product produced. Method validation results are used to determine scores, percentages and categories.

3. RESULT AND DISCUSSION

Result

The implementation of academic supervision in schools has been carried out face-to-face without using online media. The academic supervision schedule is carried out every semester once a year. However, sometimes, implementation can only be done comprehensively for some teachers because the principal is busy. The stages of supervision carried out by the school include preliminary meetings, planning, implementation, data analysis and feedback. One of the weaknesses and obstacles to implementing academic supervision in schools is the principal's need to assess teacher administration in preparing lessons. So, teachers lack readiness in teaching. This is because the principal is busy carrying out his duties and obligations as a principal. Another weakness is that school principals have a potential tendency to focus on administrative aspects or formalities rather than on substantial aspects of learning. Academic supervision is often related to meeting requirements or standards set by educational authorities. This can result in supervisors focusing more on achieving targets or formal requirements without paying in-depth attention to teacher and student interactions in the classroom. The research results based on the ADDIE stages are explained at each stage as follows.

First, analyze. The results of the research analysis conclude that the main problems with academic supervision are the limited time that the principal has to be able to supervise the principal and all teachers in the school, documentation that has not been properly prepared, difficulty finding time to provide feedback so that no continuity from supervision does not result in increased teacher competence, and decreased teacher motivation due to changing schedules. To overcome this problem, researchers created a new design for academic supervision that can accommodate problems that arise in the implementation of academic supervision, especially at Satya Wacana Christian High School, Salatiga, so that the implementation of academic supervision can run smoothly. The academic supervision model was developed with the help of a web application to implement academic supervision in schools. The academic supervision model developed is called "SUPER WATER," an academic supervision application built using the waterfall method.

Second, design. This research designed a new model of academic supervision, "SUPER WATER," which was developed based on the theory of supervision steps according to Arinkuno & Yuliana (2012), namely starting with a preliminary meeting, planning by teachers and supervisors, carrying out observations, analyzing data, providing feedback. The advantage of this model is that it combines two different techniques in implementing academic supervision, which can help teachers improve their pedagogical abilities in their duties as teachers. The technique used is that the principal can immediately

provide feedback, and there is a discussion forum menu, which is very helpful for teachers who need the principal's input quickly. The SUPER WATER academic supervision model, combined with application assistance in its implementation, can overcome problems such as limited time faced, manual documentation that needs to be properly archived, and difficulties in finding time that can be resolved well. The implementation of SUPER WATER academic supervision is carried out in an integrated manner, so it is very helpful in monitoring the development of the supervised teachers.

Third, development. Using this procedural model, researchers developed an academic supervision model using a digital platform or special application to make it easier to collect data, monitor teacher progress, and record feedback. With technology adoption, supervision can become more efficient, increase analysis accuracy, and facilitate communication between teachers and supervisors. Using video as a recording tool can allow supervisors to provide more detailed feedback and allow teachers to reflect on their teaching practices. The academic supervision design development product produced in this research is a new design book for a waterfall-based interactive academic supervision model named "SUPER WATER," equipped with a user guide to guide users using this model. The results of the development of Interactive Academic Supervision "SUPER WATER" are presented in Figure 1.

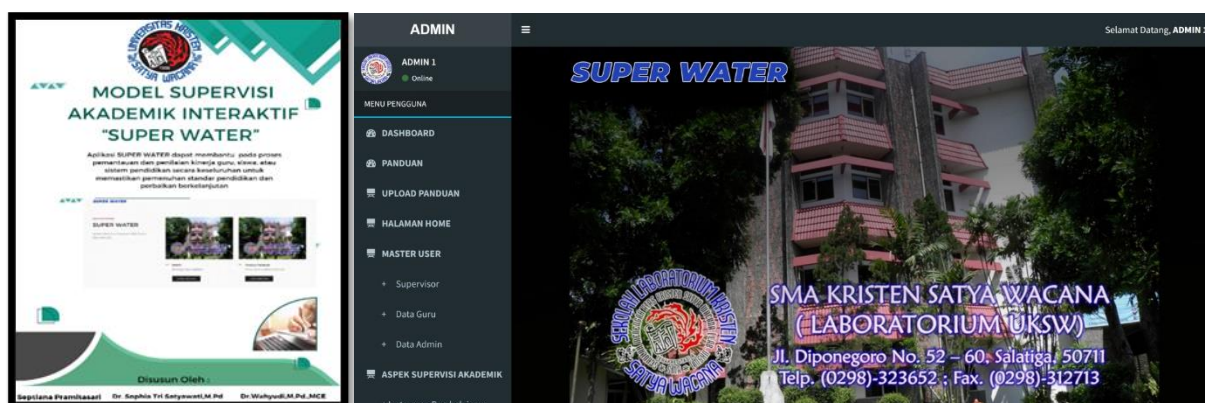


Figure 1. SUPER WATER Academic Supervision Model Book

The "SUPER WATER" Interactive Academic Supervision Model Design Book contains an Introduction, Theoretical Study, "SUPER WATER" Academic Supervision Model, Usage Guide (for Admins, Principals and Teachers), Conclusions, Suggestions, and Bibliography. Before the trial, the Model Book is validated by Supervision Experts and IT Experts. The validation results by supervision experts are presented in Table 3.

Table 3. Supervision Expert Validation Test Results on the Superwater Academic Supervision Model

No	Assessment Aspects	Score
1	Background	93%
2.	Theoretical Accuracy	87%
3.	Model Visualization	85%
4.	Model Description	84%
5.	Uses of Academic Supervision	93%
Average		88%

The average score in the table shows that the validation results by supervision experts are 88%, including those in the very valid category, so this product is worth testing. Validation results by IT experts are shown in Table 4.

Table 4. IT Expert Validation Test Results on the Superwater Academic Supervision Model

No	Assessment Aspects	Score
1	Appearance	85%
2.	Access	100%
3.	Interaction	100%
4.	Control	90%
Average		94%

The average score in the table shows that the validation results by supervision experts are 94%, which is in the very valid category, so this product is worth trialing. Before the trial, the researcher made revisions based on input from the two experts so that it was worthy of trialing. Input from supervision experts is 1) In the supervision step, theory should be added from figures such as Glickman, Marzano, Hoy, and Sergiovani, 2) In the supervision model picture, explain what model will be used, and 3) The model used in academic supervision given in theoretical studies. Input from IT experts is that application performance testing needs to be carried out to ensure that the application can be accessed normally by many users at one time. Fourth is implementation. The principal and five teachers at Satya Wacana Christian Middle School, Salatiga, were tested at the implementation stage. This trial resulted in an assessment of the "SUPER WATER" Academic Supervision Model, which is presented in [Table 5](#).

Table 5. Assessment Results of the "SUPER WATER" Academic Supervision Model by the School Principal

No	Assessment Aspects	Score
1.	Appearance	91%
2.	Access	90%
3.	Supervision model design	92%
4.	Model description	90%
5.	Design a guidebook for using SUPER WATER	90%
Average		91%

The average score in the table shows that the school principal's assessment results after the trial were 91%, including in the very valid category, so this product is worth testing. Meanwhile, [Table 6](#) shows the results of five teachers' assessments of the "SUPER WATER" Academic Supervision Model after the trial.

Table 6. Assessment Results of the "SUPER WATER" Academic Supervision Model by Teachers

No	Assessment Aspects	Score
1.	Appearance	95%
2.	Aspect	90%
3.	Interaction	90%
4.	Design a guidebook for using SUPER WATER	90%
5.	The usefulness of the Academic Supervision Model	92%
Average		91%

The average score in the table shows that the results of the assessment by teachers after the trial were 91%, which is included in the very valid category, so this product is worth testing. Some of the input the teacher gives is information in the application by the teacher or principal. Please write it in each item in the application. Fifth is evaluation. First, evaluation can be carried out at the evaluation stage by involving teacher participation. Receiving feedback from teachers about their experiences during supervision can provide valuable insight into the extent to which the supervision approach was successful and the extent to which teachers feel supported in their professional development. Furthermore, evaluation can involve analysis of student performance data as a result of corrective actions or implementation of suggestions from supervision. Improvements in student achievement or positive changes in other educational metrics can be indicators of successful academic supervision. Therefore, the availability of relevant quantitative data and long-term monitoring will help assess the long-term impact of supervision efforts.

Discussion

The results of data analysis show that the new design of interactive academic supervision using the waterfall method has received very valid qualifications from experts and teachers. This shows that the new design of interactive academic supervision using the waterfall method is suitable for use. This is caused by several factors, namely as follows. First, the new design of interactive academic supervision using the waterfall method is suitable because it helps improve teachers' pedagogical competence. The findings from this research show that academic supervision aims to help teachers improve their abilities and skills in carrying out the learning process. Teachers feel the assistance provided by the principal in improving their professional duties ([Masnun, 2017](#); [Suwartini, 2017](#)). The program in each school determines the implementation of academic supervision in schools. This shows that the school has

implemented continuous supervision, which always involves monitoring to ensure teachers can carry out their teaching duties well (Yussanti & Dwikurnaningsih, 2020; Yusup, 2017).

Second, the new design of interactive academic supervision using the waterfall method is suitable because it assesses the long-term impact of supervision efforts. Academic supervision is crucial in education (Masnun, 2017; Suwartini, 2017). Research findings state that supervision determines the quality of teachers at the forefront of education in Indonesia (Usman, 2018; Yusup, 2017). This is confirmed by research, which emphasizes that supervision is very important to developing teachers' pedagogical competence as teachers (Musyadad et al., 2022; Ningrat et al., 2020; Sukarmen, 2018). Therefore, the government has determined that supervision is mandatory in every educational unit in Indonesia. Based on the results of interviews with school principals, supervision was carried out with the full understanding that this could affect the quality of the school. With academic supervision, schools can improve teacher performance in teaching students, influencing the quality of school graduates. When schools supervise by prioritizing family relationships, teachers desire to increase their teaching potential (Dwikurnaningsih, 2018; Prastania & Sanoto, 2021). Teachers in these four schools feel the assistance provided by the principal in improving their professional duties.

Third, the new design of interactive academic supervision using the waterfall method is suitable because it makes it easier to carry out supervision. One of the important roles in academic supervision is the leadership role of the school principal so that it can improve teacher performance (Berliani & Wahyuni, 2020; Fahmi et al., 2018; Sitaasih, 2020). This is emphasized by research that reveals the role of the school principal, which greatly influences teachers' performance in schools (Ghifar et al., 2019; Widyantara, 2019). The school principal holds an important key in monitoring and improving the quality of the school (Maris et al., 2016; Syafrizal, 2017). The school principal has succeeded in being able to lead them, guide them, and provide direction to improve the competence of teachers. These school principals are aware of the burden they have to ensure quality. This is in line with the statement that the efforts made by the school principal to supervise the learning process have an important influence (Minsih et al., 2019; Mukhlisin, 2021; Putri & Wibowo, 2018). This is by the function of the school principal as supervisor, teacher, manager, administrator, leader, innovator and motivator (Lisnawati, 2018; Maris et al., 2016; Syafrizal, 2017). School principals have a large burden to carry out their functions appropriately, especially regarding academic supervision.

Previous research also revealed that ongoing academic supervision is needed to develop teachers' performance in educational units (Musyadad et al., 2022; Ningrat et al., 2020; Sukarmen, 2018). Other research also states that using technology can be an alternative to doing supervision differently (Asmarani et al., 2021; Sarjono, 2020). In the pre-pandemic period and during the pandemic, technology can help solve problems that arise when implementing academic supervision. The limitation of this research is that the interactive academic supervision using the developed waterfall method has yet to be tested for effectiveness. However, it can still be used because the qualifications are very valid. This research implies that Waterfall is an alternative technology that can be used to overcome problems that arise at this time—the effectiveness of the application so that interactions can be carried out easily. The application can also overcome problems with its features, such as organized and unlimited storage, easy group creation, and easy communication between school principals and teachers. It is recommended that school principals use digital supervision so that it is more flexible.

This research highlights several limitations that need to be considered in its implementation. First, although the new design of interactive academic supervision using the waterfall method has received very good validation from experts and teachers, effectiveness tests have yet to be carried out to measure actual performance in a practical context. Second, the limitations of the subject and scope of the research also need to be taken into account, where testing was only carried out on a new design of interactive academic supervision using the waterfall method without expanding the scope to a wider environment or educational level. While it has the advantage of facilitating improvements in teachers' pedagogical competence and helping evaluate the long-term impact of supervision efforts, the quality of evaluation results and their impact may only be fully measurable with comprehensive effectiveness testing. On the other hand, this research shows the advantages of increasing teacher pedagogical competence through a structured supervision approach. These findings emphasize the importance of academic supervision in improving the quality of education, which is in line with the government's efforts to improve the quality of teachers in Indonesia.

Moreover, this new supervision design makes it easier for school principals to carry out their supervisory duties and improve their overall quality by providing appropriate teacher support. This research implores Waterfall technology as an alternative to implementing academic supervision, providing flexibility and effectiveness in interactions between school principals and teachers. Although

further testing is still needed, this digital supervision application could be a promising solution for improving the quality of academic supervision.

4. CONCLUSION

The results of data analysis show that the new design of interactive academic supervision using the waterfall method has received very valid qualifications from experts and teachers. It was concluded that the new design of interactive academic supervision using the waterfall method was suitable for use. The new design of interactive academic supervision using the waterfall method can make supervision easier. Apart from that, the new design of interactive academic supervision using the waterfall method is suitable because it helps improve teachers' pedagogical competence. School principals can use the SUPER WATER academic supervision model to carry out academic supervision more flexibly so that it can be carried out comprehensively for teachers and by the program that has been set.

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