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Pembelajaran Matematika Berbasis *Unity of Sciences* di Sekolah Menengah Atas Berbasis Islam

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Abstrak

Penelitian ini bertujuan untuk mengalanisis implementasi pembelajaran matematika berbasis *unity of sciences* di sekolah menengah atas berbasis Islam. Penelitian kualitatif dengan desain studi kasus ini mengumpulkan data melalui wawancara mendalam, observasi, survei, dan dokumentasi di MA Yaspia Ngroto Gubug Grobogan. Subjek penelitian ini adalah lima responden yang terdiri dari tiga siswa kelas X, satu guru matematika kelas X, dan satu kepala sekolah. Hasil penelitian menunjukkan bahwa pembelajaran matematika berbasis *unity of sciences* memiliki manfaat signifikan, seperti mengintegrasikan berbagai disiplin ilmu, membuat pembelajaran lebih relevan dan menarik, serta menciptakan lingkungan belajar yang dinamis dan interaktif. Namun, ada beberapa tantangan utama yang dihadapi antara lain kompetensi guru, keterbatasan sumber daya, kurikulum yang kurang fleksibel, dan adaptasi siswa terhadap metode pembelajaran baru. Untuk mengatasi tantangan ini, penelitian menemukan beberapa strategi yang dapat diterapkan yaitu pelatihan intensif dan berkelanjutan bagi guru, penyediaan sumber daya yang memadai, pengembangan kurikulum yang fleksibel, pembentukan komunitas belajar antar-guru berbagai disiplin ilmu, serta penerapan strategi pengajaran yang memfasilitasi transisi siswa. Untuk penelitian selanjutnya, disarankan untuk memperluas cakupan penelitian dengan melibatkan lebih banyak sekolah dan responden dari berbagai daerah. Penggunaan metode penelitian yang lebih beragam, seperti survei kuantitatif, observasi kelas, dan studi kasus yang mendalam, juga dapat memberikan data yang lebih kaya dan lebih komprehensif.
Kata Kunci: dikotomi ilmu, inovasi pembelajaran, pembelajaran matematika, *unity of sciences*

Unity of Sciences-Based Mathematics Learning in an Islamic High School

Abstract

This study aims to analyze the implementation of mathematics learning based on the unity of sciences in Islamic senior high schools. This qualitative research with a case study design collected data through in-depth interviews, observations, surveys, and documentation at MA Yaspia Ngroto Gubug Grobogan. The subjects of this study were five respondents consisting of three grade X students, one grade X mathematics teacher, and one principal. The study results indicate that mathematics learning based on the unity of sciences has significant benefits, such as integrating various disciplines, making learning more relevant and interesting, and creating a dynamic and interactive learning environment. However, several major challenges are faced, including teacher competence, limited resources, less flexible curriculum, and student adaptation to new learning methods. To overcome these challenges, the study found several strategies that can be applied, namely intensive and ongoing training for teachers, provision of adequate resources, development of flexible curriculum, formation of learning communities between teachers of various disciplines, and implementation of teaching strategies that facilitate student transitions. For further research, it is recommended to expand the scope of the study by involving more schools and respondents from various regions. The use of a wider variety of research methods, such as quantitative surveys, classroom observations, and in-depth case studies, can also provide richer and more comprehensive data.
***Keywords**: learning innovation; math learning; science dichotomy; unity of sciences*

INTRODUCTION

The lack of learning that teaches the unity of science is an old problem in education that is often referred to as the dichotomy of science (Ika et al., 2023). This term refers to an understanding that distinguishes between general science and religious science, which results in the two being considered separate (Wahyu Aji et al., 2023). As a result, general sciences, such as mathematics, become very distant from students' daily lives. This makes formal schooling often only considered a formality and does not support students' social and religious lives. In fact, as a religious and educated person, especially for Muslims, it is important to be able to integrate the religious knowledge they have with the science they learn. History has recorded that during the golden age of Islam, Muslim scientists succeeded in discovering scientific knowledge through religious values in their works. This kind of integrated learning is very important to develop so that education does not only become a means of formality but also truly benefits the social and spiritual lives of students. Thus, education that unites general science and religion can form individuals who are knowledgeable and have a deep religious awareness, ready to face the challenges of the modern world with a strong moral foundation (Hamdy & Huda, 2023). This approach is in line with the unity of sciences-based mathematics learning, where mathematical concepts are not only taught as separate disciplines but are integrated with other disciplines, including science and religion so that students can see their relevance and application in various aspects of their lives (Wahyuni, 2020). In this way, mathematics becomes more contextual and meaningful, helps students develop a more holistic and integrative understanding, and overcomes the dichotomy of knowledge that has hindered the development of a comprehensive and useful education (Muchtar & Sunhaji, 2022). However, Unity of Sciences-based mathematics learning is often perceived as challenging by teachers and schools (De Souza & De Oliveira, 2024). This perception makes many teachers hesitate or even avoid implementing the approach, even though they understand the importance of science integration in improving student understanding. This concern usually arises because teachers feel that they are not competent enough to teach various disciplines in an integrated manner, as well as due to the lack of adequate support and resources from the school. In addition, some schools that have tried to implement this learning often discontinue it due to various obstacles they face. These barriers have made efforts to continue the unity of sciences approach unsustainable, especially since the right strategies have not been found to overcome these problems (Alberida, 2020). If implemented well, this approach can make a significant contribution to shaping a holistic mindset in students, which is very relevant in facing today's global challenges.

Research on the unity of sciences-based learning has so far mostly discussed the development of teacher competencies and the implementation of the unity of sciences-based learning itself. For example, Arsini (2015) in improving teacher competence through the creation of the portal "Unity of Science-Based Science Learning Channel," as well as research by Syukur & Junaedi (2017) on unity of sciences-based teacher professional development, provides valuable insights related to efforts to improve the quality of education through this approach. Similarly, research conducted by Anbiya & Asyafah (2020) in the implementation of unity of sciences-based civic learning, as well as research by Siraj et al. (2023) in developing a reflective learning model for prospective professional vocational high school teachers, also makes an important contribution to the development of holistic learning methods. However, research that discusses the implementation of unity of sciences-based mathematics learning in Islamic-based high schools is still rare. This research is important because educators and policymakers can understand the challenges faced in integrating various disciplines. It can also help find effective strategies to overcome these barriers. Moreover, it can provide empirical evidence on the benefits and impact of this approach on student understanding, which in turn can encourage wider adoption and overall improvement in the quality of education. Without in-depth research, the implementation of unity of sciences-based mathematics learning cannot reach its full potential, and the existing challenges may continue to hinder the development of interdisciplinary education.

In response to this phenomenon, this research aims to examine the implementation of mathematics learning based on the unity of sciences in Islamic-based Senior High Schools focusing on Madrasah Aliyah Yaspia Ngroto Gubug Grobogan. Mathematics learning based on the unity of sciences integrates

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various disciplines to enrich students' understanding of mathematical concepts. The focus of this research includes three main aspects: first, how the implementation of unity of sciences-based mathematics learning is carried out in Islamic-based Senior High Schools; second, the main challenges faced in implementing this method; and third, strategies that can be used to overcome these challenges. This research needs to be conducted at MA Yaspia Ngroto Gubug Grobogan because this madrasah is committed to improving the quality of education and the application of innovative learning methods. In addition, the results of this study are expected to provide new insights and practical solutions for other schools facing similar challenges, as well as strengthen the argument that the unity of sciences approach can improve students' understanding and interest in mathematics.

In this study, we use Jean Piaget's cognitive development theory as an analytical knife because research on the implementation of unity of sciences-based mathematics learning in Islamic-based high schools is very feasible to study using Jean Piaget's cognitive development theory. Piaget suggested that students' cognitive development progresses through four stages: sensorimotor, preoperational, concrete operational, and formal operational (Piaget, 1952). Students in senior high school are generally at the formal operational stage, where they begin to be able to think abstractly, logically, and systematically (Kıncal & Yazgan, 2010). Learning based on the unity of sciences can provide a real context that supports the transition to abstract thinking, by linking mathematical concepts with other disciplines (King & Ritchie, 2012). In addition, the integration of different disciplines can stimulate students' interest and motivation to learn, as they see the direct relevance of what they are learning. However, the main challenge lies in teachers' readiness to implement this approach and limited resources (Afifa et al., 2022). Therefore, teacher training strategies and the provision of adequate resources are essential. By addressing these challenges, the opportunity to create more meaningful and engaging learning for students can be realized, in line with the principles of cognitive development proposed by Piaget. This research provides an in-depth insight into how the application of unity of sciences can facilitate students' cognitive development at the formal operational stage.

METHOD

This research method uses a qualitative approach with a case study design to explore the implementation of mathematics learning based on the unity of sciences in Islamic-based high schools, especially in Madrasah Aliyah Yaspia Ngroto Gubug Grobogan. The case study approach was chosen because it can obtain a deepening of analysis in a specific context, providing a comprehensive understanding (Ratnasari & Sudradjat, 2023) of how the concept of unity of sciences is applied and the challenges and strategies that can be used to overcome existing challenges. Data were collected through four techniques: in-depth interviews, observations, surveys, and documentation. In-depth interviews with teachers and students were used to explore their perceptions, experiences, and views on this learning. Observations were made in the classroom to directly observe the implementation of the learning method and the interactions that occur. Surveys were used to complement the findings from interviews and observations, providing an overview of students' and teachers' attitudes and responses. Documentation, such as curriculum, lesson plans, and school reports, were analyzed to understand the framework and formal implementation of the unity of sciences-based learning. Data were collected systematically with interview schedules, classroom observations over several sessions, distribution of surveys to students and teachers, and collection of school documents. This combination of data collection techniques ensures triangulation, strengthening the validity and reliability of the research findings (Noble & Heale, 2019).

To ensure the standard and validity of interview, observation, and survey instruments, data triangulation techniques were applied through source, method, and time triangulation. Source triangulation involves collecting data from various informants, such as teachers, students, and school documents, to obtain diverse perspectives and strengthen research results. Method triangulation uses a combination of observation, in-depth interviews, surveys, and documentation analysis, with cross-verification between methods to increase the accuracy of research results. Time triangulation is done by collecting data at different times to assess the consistency of findings and understand changes that occur. The data analysis technique used is the Miles and Huberman interactive model, which includes three

main stages: data reduction, data presentation, and drawing/verifying conclusions (Miles & Huberman, 1994). Data collected from various sources and methods are coded and reduced to identify key themes and relevant patterns (Saldaña, 2015). The reduced data is then presented in the form of a matrix or graph to facilitate analysis and interpretation (Miles et al., 2014). Conclusions are drawn by continuously comparing data, looking for relationships or differences, and verifying to ensure the accuracy of the findings (Yin, 2018). By using this triangulation, the research is expected to provide a comprehensive and in-depth picture (Denzin, 2012) of the implementation of mathematics learning based on the unity of sciences in Islamic-based high schools.

This research was conducted at MA Yaspia Ngroto Gubug Grobogan, an Islamic-based high school with a high commitment to innovation in learning. This madrasah was chosen because of its reputation for integrating various disciplines into the curriculum, by the unity of sciences approach that is the focus of the research. In addition, the school has a conducive environment for the implementation of holistic and interdisciplinary learning methods. The selection of respondents in this study was done purposively to ensure representation that is relevant to the context of unity of sciences-based mathematics learning in Islamic High Schools. The five respondents selected consisted of three tenth-grade students, one tenth-grade mathematics teacher, and one principal. The tenth-grade students were chosen because they were in the early stages of implementing this learning, so could provide a fresh view of their experiences. The math teacher was chosen for her direct role in designing and implementing the unity of sciences-based learning, while the principal was chosen to provide a policy perspective and institutional support for the implementation of this learning. This diverse selection of respondents aims to collect rich and in-depth data from various perspectives, to provide a comprehensive picture of the implementation of unity of sciences-based learning, both from the perspective of students, teachers, and school management.

Table 1. Respondents' profile

No.	Initial	Profile
1.	S1	Students
2.	S2	Students
3.	S3	Students
4.	G	Teacher
5.	KS	School Principal

The research was conducted from January 2024 to May 2024, a sufficient period to conduct thorough observations, in-depth interviews, surveys, and document analysis. Madrasah Aliyah Yaspia Ngroto Gubug Grobogan provides an ideal context to explore the implementation of unity of sciences-based mathematics learning, due to its dedication to improving the quality of education and implementing innovative teaching methods. The results of this study are expected to make a valuable contribution to the development of more integrative and effective educational practices in similar schools.

RESULTS

Implementation of Mathematics Learning Based on Unity of Sciences in Islamic-Based High Schools

Observations were made in class X A at MA Yaspia Ngroto Gubug Grobogan regarding the implementation of mathematics learning based on the unity of sciences. The classroom atmosphere looks dynamic and interactive, with students showing a high level of enthusiasm. The teacher started the lesson by linking the concept of trigonometry with its application in other disciplines, especially in determining the angle magnitude using three points assisted by the GeoGebra application on the computer. The use of digital props and computer simulations helped students visualize the concept, making it easier for them to understand the material presented. After that, students are asked to discuss the relationship of the mathematics material taught with other disciplines with the help of a mathematics learning module based on the unity of sciences (as seen in Figure 1).

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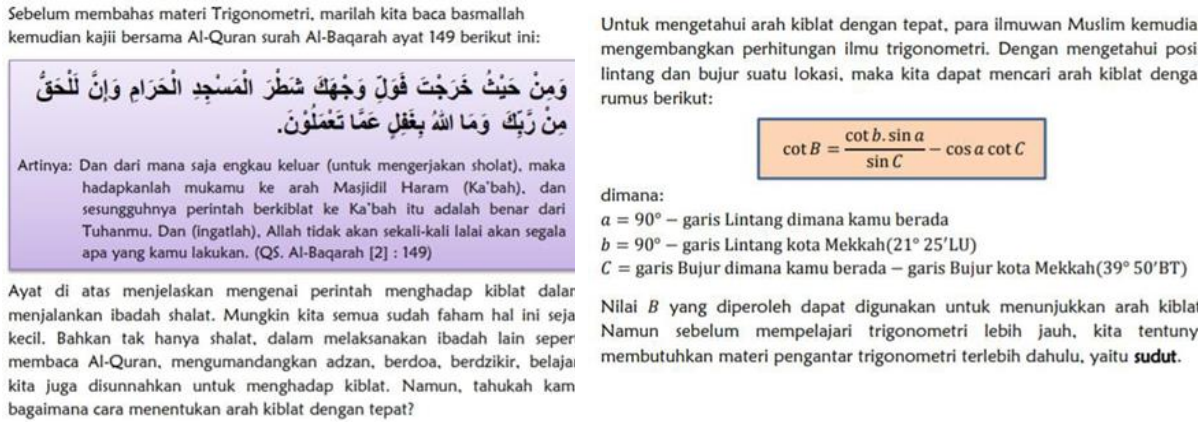

Sebelum membahas materi Trigonometri, marilah kita baca basmallah kemudian kajii bersama Al-Quran surah Al-Baqarah ayat 149 berikut ini:

وَمِنْ حَيْثُ خَرَجْتَ فَوَلِّ وَجْهَكَ شَطْرَ الْمَسْجِدِ الْحَرَامِ وَإِنَّهُ لَلْحَقُّ مِنْ رَبِّكَ وَمَا اللهُ بِغَفِلٍ عَمَّا تَعْمَلُوْنَ.

Artinya: Dan dari mana saja engkau keluar (untuk mengerjakan sholat), maka hadapkanlah mukamu ke arah Masjidil Haram (Ka'bah), dan sesungguhnya perintah berkiblat ke Ka'bah itu adalah benar dari Tuhanmu. Dan (ingatlah), Allah tidak akan sekali-kali lalai akan segala apa yang kamu lakukan. (QS. Al-Baqarah [2] : 149)

Ayat di atas menjelaskan mengenai perintah menghadap kiblat dalar menjalankan ibadah shalat. Mungkin kita semua sudah faham hal ini seja kecil. Bahkan tak hanya shalat, dalam melaksanakan ibadah lain seper membaca Al-Quran, mengumandangkan adzan, berdoa, berdzikir, belaja kita juga disunnahkan untuk menghadap kiblat. Namun, tahukah kam bagaimana cara menentukan arah kiblat dengan tepat?

Untuk mengetahui arah kiblat dengan tepat, para ilmuwan Muslim kemudia mengembangkan perhitungan ilmu trigonometri. Dengan mengetahui posi lintang dan bujur suatu lokasi, maka kita dapat mencari arah kiblat denga rumus berikut:

$$\cot B = \frac{\cot b . \sin a}{\sin C} - \cos a \cot C$$

dimana:
$a = 90° -$ garis Lintang dimana kamu berada
$b = 90° -$ garis Lintang kota Mekkah($21° 25'$LU)
$C =$ garis Bujur dimana kamu berada $-$ garis Bujur kota Mekkah($39° 50'$BT)

Nilai B yang diperoleh dapat digunakan untuk menunjukkan arah kibla Namun sebelum mempelajari trigonometri lebih jauh, kita tentuny membutuhkan materi pengantar trigonometri terlebih dahulu, yaitu **sudut**.

Figure 1. Implementation of Unity of Sciences-Based Mathematics Learning

In Figure 1, it can be seen that the teacher relates the trigonometry material to the direction of the Qibla. Figure 1 shows that learning begins with information from the Quranic verses regarding the command to face the Qibla, to the formula from mathematical scientists to determine the direction of the Qibla mathematically. In addition to the material, the questions given to students are also related to religious knowledge. One of the questions about angles is shown in Figure 2.

Figure 2. Questions given to students

Figure 2 shows the questions given to students regarding angles related to prayer positions. Students are asked to convert the angles formed during bowing into radians. Students' answers are shown in Figure 3.

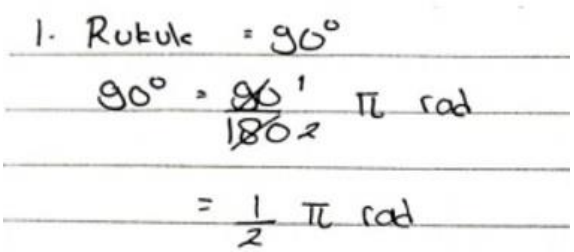

Figure 3. Students' answers

Figure 3 shows that students can answer the questions correctly. Students can convert angles into radians. With the unity of science-based learning, students receive information that mathematics is related to other subjects, as seen in the interview transcript.

Researcher : What do you think about learning math based on the unity of sciences?
S1 : Through this unity of sciences-based learning, I came to know that math is related to other subjects.

Based on the interview transcript, shows that learning based on the unity of science helps students see the relationship between various fields of science and the relevance of science in everyday life. This can prepare them to face complex future challenges. Meanwhile, informant S2 stated that mathematics learning based on the unity of science makes learning more relevant and interesting for students, as seen in the following interview transcript.

Researcher : What do you think about learning math based on the unity of sciences?"
S1 : With this learning, it makes me not feel bored with math which seems to be just that and from here it makes me more interested in mathematics because it turns out that mathematics has a connection with other subject matter or life. In addition, this learning makes me think extra because what is being solved is not only about math.

Based on the interview transcript, this approach allows students to see how mathematics is not only a series of numbers and abstract formulas, but also a powerful tool for understanding and solving problems in other sciences. By linking mathematical concepts with real-world situations, students can more easily understand and appreciate the usefulness and importance of mathematics in everyday life. This approach can also increase students' interest in math, as they can see the direct relevance of what they are learning. When students understand how math is used in various contexts, they tend to be more motivated to learn and explore more deeply. In addition, this interdisciplinary learning encourages the development of critical thinking skills and more complex problem-solving, as students have to integrate knowledge from different fields to complete a task or project.

Apart from students, interviews were also conducted with teachers (namely informant G). Informant G stated that the unity of sciences-based mathematics learning can create a more dynamic and interactive learning environment by combining various disciplines and encouraging collaboration between students and teachers.

Researcher : What is your opinion as a teacher regarding mathematics learning based on the unity of sciences?"
G : Unity of sciences-based mathematics learning creates a dynamic and interactive environment, encouraging collaboration between students and teachers. Inter-teacher collaboration enriches the learning experience, and educational technologies such as computer simulations also support the exploration of complex concepts, discussion, and critical thinking skills, improving student understanding and learning outcomes.

The Main Challenges Faced in Learning Mathematics Based on Unity of Sciences In Islamic-Based High Schools

Learning mathematics based on the unity of sciences at MA Yaspia Ngoto Gubug Grobogan faces several major challenges that need to be overcome to achieve success. One of the biggest challenges is teachers' readiness and competence in integrating various disciplines into mathematics learning. In addition, limited resources, such as adequate teaching materials and teaching aids that support the unity of sciences-based learning, are also a significant obstacle. A strict curriculum and limited time to explore cross-disciplinary concepts can hinder the implementation of this method. Another challenge is resistance from students who find it difficult to relate mathematical concepts to other disciplines, especially if they are used to traditional learning approaches. In addition, support from school management and educational policies that support this approach is also very important. Without adequate support, both in terms of policy and infrastructure, efforts to implement unity of sciences-based learning could face major obstacles.

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In this regard, informant KS stated that the main challenge faced in learning mathematics based on the unity of sciences is the readiness and competence of teachers in integrating various disciplines into mathematics learning.

Researcher	:	*What do you think is the biggest challenge in implementing unity of sciences-based mathematics learning?"*
KS	:	*Many teachers struggle to design and implement curricula that connect mathematics with other disciplines because they are used to traditional approaches. Limited training and professional development are also significant barriers.*

Meanwhile, informant G stated that the main challenge faced in learning mathematics is based on the unity of sciences.

Researcher	:	*What do you think is the biggest challenge in implementing unity of sciences-based mathematics learning?"*
G	:	*The main challenge is the limited resources such as comprehensive teaching materials, teaching aids, and educational technology to support interdisciplinary learning. Teachers often have to develop materials themselves, which requires additional time and expertise. Lack of financial and logistical support and unsupportive infrastructure are also significant barriers.*
Researcher		*Is there anything else?*
G	:	*In addition, he rigorous curriculum and limited time to explore cross-disciplinary concepts. The tight curriculum and exam pressure also hinder integrative approaches and interdisciplinary collaborative projects that require additional time.*

Based on the interview transcript of informant G, the teacher stated that the main challenge faced in learning mathematics based on the unity of sciences is the limited resources, such as adequate teaching materials and teaching aids that support interdisciplinary learning. The availability of comprehensive and relevant teaching materials that integrate mathematics with other disciplines is still very limited. Teachers often have to develop their materials, which requires additional time, effort, and expertise. In addition, teaching aids and educational technology needed to support the unity of sciences-based learning, such as computer simulations and interactive software, are often unavailable or difficult to access. Furthermore, informant G also stated that a tight curriculum and limited time to explore interdisciplinary concepts could hinder the effective implementation of this method. A dense curriculum is often already tightly structured, leaving little room for teachers to interject interdisciplinary material that requires more time for in-depth exploration and understanding. Teachers are bound by demands to complete the syllabus in a limited time, which often forces them to focus on achieving conventional academic targets rather than developing a more integrative and holistic approach to learning.

In addition, informant S3 stated that the main challenge in learning mathematics based on the unity of sciences is students who find it difficult to relate mathematical concepts to other disciplines, especially if they are used to traditional learning approaches. Many students who have long been taught with conventional methods that tend to separate mathematics from other sciences make students experience confusion and difficulty when asked to understand and apply mathematical concepts in an interdisciplinary context. This limited understanding can confuse and reduce their motivation to learn. In addition, students also feel burdened by the additional complexity brought by the unity of sciences approach, which requires them to understand and integrate information from various disciplines.

Researcher	:	*Were there any obstacles that you experienced while learning mathematics based on the unity of sciences? If so, what were they?*
S3	:	*The difficulty is that the material studied is more and the problems are more diverse, especially at the beginning I was really surprised because*

usually, math is just math, it feels confused about what to do and it's difficult so at the beginning I felt even lazy when learning math. But as time goes by, I can understand and even get interested.

Based on this explanation, it can be seen that mathematics learning based on the unity of sciences at MA Yaspia Ngroto Gubug Grobogan is faced with several major challenges that must be overcome to be successful. Based on the interviews conducted, several challenges faced were concluded and presented in Figure 4.

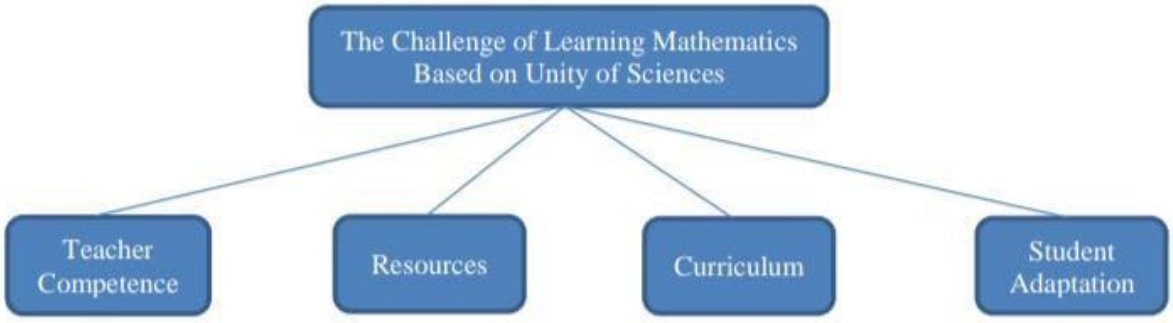

Figure 4. The Challenge of Learning Mathematics Based on Unity of Sciences

Strategies to Overcome the Main Challenges Faced in Learning Mathematics Based on Unity of Sciences In Islamic-Based High Schools

To overcome the main challenges in learning mathematics based on the unity of sciences that have been described, several strategies can be effectively implemented. Based on the interviews conducted, several strategies were offered by respondents to face challenges in implementing unity of science-based learning.

Researcher	:	*What strategies are in place to overcome these challenges or problems?*
KS	:	*To overcome the challenges, there is a need for continuous training for teachers to integrate mathematics with other sciences. Workshops, seminars, and courses on interdisciplinary methodologies, innovative teaching techniques, and educational technology should be part of the program."*
Researcher		*Is there anything else?*
KS		*The formation of learning communities between teachers from different disciplines is one strategy that can also be applied. Ongoing collaboration and exchange of ideas within the community can lead to richer and more varied approaches to learning. Learning communities can also provide moral and professional support, helping teachers overcome resistance to changes in teaching methods."*

Based on the interview transcript, informant KS stated that training and continuous professional development for teachers are very important to improve their competence in integrating various disciplines into mathematics learning. Teachers need to be equipped with the necessary knowledge and skills to combine mathematical concepts with other sciences. In addition, informant KS also stated that the formation of learning communities between teachers from various disciplines is also implemented. This learning community encourages continuous collaboration and exchange of ideas, resulting in richer and more varied learning approaches.

In addition, informant KS also stated that teachers need to implement teaching strategies that facilitate students' transition from traditional learning to an integrative approach. One way is to use more interactive and contextualized teaching methods, such as problem-based projects or case studies. These methods allow students to see the real-life applications of mathematical concepts in other sciences, helping them to develop a more holistic understanding and improve their ability to link the concepts

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learned. This interactive approach can include the use of technology, such as computer simulations or other digital tools, to visualize mathematical concepts in a scientific context. By providing appropriate support, teachers can help students understand more complex concepts and overcome difficulties that arise. In this way, the challenges of relating mathematics to other disciplines can be minimized, making it easier for students to adapt to and benefit from the unity of sciences-based learning. As a result, students not only have a deep understanding of mathematics but are also able to apply their knowledge in a real-world context.

Researcher : *In addition, some students stated that one of the challenges they felt at the beginning was that they were not used to learning math based on the unity of science, so what strategies were used to overcome these challenges or problems?*

KS : *We encourage teachers to use teaching strategies that facilitate students' transition from traditional learning to integrative approaches, such as problem-based projects or case studies. With the right support, students can grasp more complex concepts and overcome difficulties in relating math to other disciplines, making it easier for them to adapt and benefit from learning.*

Meanwhile, informant G stated that to overcome the main challenges in learning mathematics based on the unity of sciences, the provision of adequate resources, including interdisciplinary teaching materials and relevant teaching aids, is very important to support the implementation of this method.

Researcher : *What strategies are in place to overcome these challenges or problems?"*

G : *To overcome the challenges in learning mathematics based on the unity of sciences, it is necessary to provide interdisciplinary teaching materials and teaching aids such as digital modules, case studies, and interactive applications to help teachers deliver materials holistically because, with adequate resources, teachers can increase student engagement and enrich the learning process.*

Furthermore, informant G stated that the development of a flexible curriculum is needed to provide space for the exploration of concepts across disciplines without being hampered by strict time constraints. A more flexible curriculum allows teachers to integrate various disciplines more freely, providing opportunities for students to understand how mathematical concepts are applied in the context of other sciences. Flexibility in scheduling is also important so that teachers have enough time to delve into the material and encourage broader and deeper exploration. Reducing the pressure of overly rigorous standardized tests and rigid assessments can make room for more creative and innovative approaches to learning. In addition, collaboration between teachers from different disciplines should be encouraged to design and implement holistic and integrative lessons. Support from school management and education policies that recognize the importance of interdisciplinary approaches help realize this flexible curriculum. Thus, students will not only learn mathematics in isolation but also understand and apply their knowledge in a broader, real-world context, ultimately improving the quality of education and the relevance of learning for their lives.

Researcher : *Are there any other strategies that can be implemented to address this challenge or problem?"*

G : *The provision of interdisciplinary teaching materials and teaching aids is also crucial. Digital modules, case studies, and interactive apps help teachers deliver materials holistically. Investment in education technology and policy support are essential for the sustainability of this approach. With adequate resources, teachers can increase student engagement and enrich the learning process.*

Based on this explanation, it can be seen that to overcome the main challenges in learning mathematics based on the unity of sciences, several effective strategies can be applied. This strategy is presented in Figure 5.

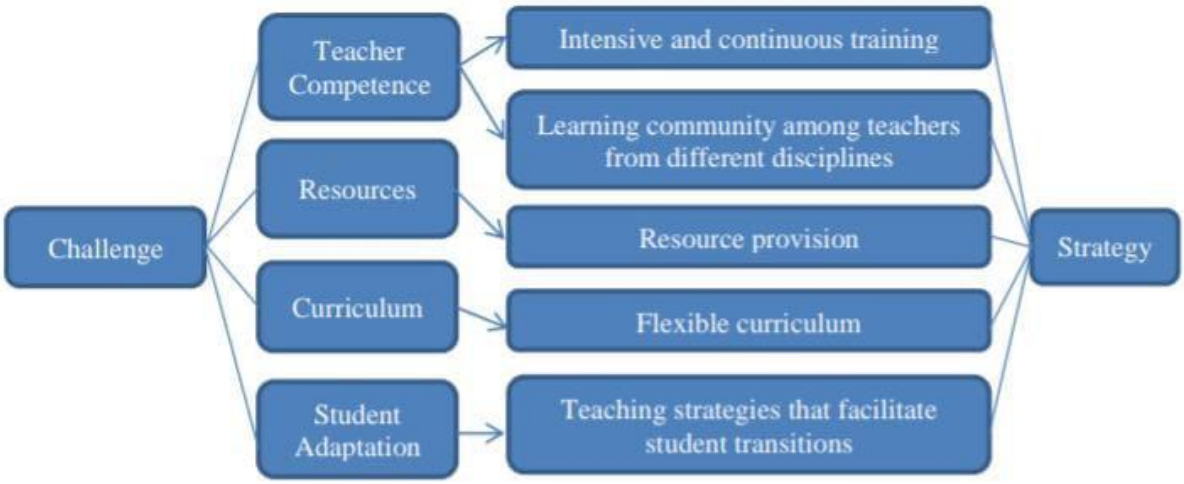

Figure 5. Strategies to Overcome the Challenges of Unity of Sciences-Based Mathematics Learning

Based on Figure 5, several strategies can be carried out. First, continuous training and professional development for teachers is essential to improve their ability to integrate various disciplines into mathematics learning. This training program can include workshops, seminars, and collaboration with experts from various disciplines. Secondly, the provision of adequate resources, such as interdisciplinary teaching materials and relevant teaching aids, can support the implementation of this method. Flexible curriculum development is also needed to provide space for the exploration of interdisciplinary concepts without being constrained by strict time limits. In addition, the formation of learning communities between teachers from different disciplines can encourage collaboration and exchange of ideas, resulting in richer and more varied learning approaches. Teachers also need to implement teaching strategies that facilitate students' transition from traditional learning to a more integrative approach. The use of educational technology, such as simulations and interactive learning applications, can help bridge the gap between theory and practice. Actively involving students in the learning process with a project-based approach can increase their interest and understanding of interdisciplinary concepts. With these strategies, the challenges of learning mathematics based on the unity of sciences can be overcome, creating a more effective and engaging learning environment for students.

DISCUSSION

Research at MA Yaspia Ngroto Gubug Grobogan found that mathematics learning based on the unity of sciences successfully integrates various disciplines, makes learning more relevant and interesting for students, and creates a more dynamic and interactive learning environment. By linking mathematical concepts with other sciences, students can see the real application of what they learn, thus increasing their interest and motivation (Radiusman, 2020). However, this study also identified some key challenges that need to be addressed for the successful implementation of this method. The challenge of teacher competence arises as many teachers still need to improve their ability to integrate various disciplines (Dhewantoro, 2018). In addition, limited resources, such as relevant teaching materials and teaching aids, are also an obstacle (Meier et al., 1998). A less flexible curriculum reduces the space for teachers to optimally implement this approach (Jonker et al., 2020). Finally, students' adaptation to new and more interactive learning methods also requires extra time and support (Paramythis & Cristea, 2008).

Facing these challenges, teachers at MA Yaspia Nroto Gubug Grobogan implement several strategies. First, intensive and continuous training for teachers is essential to improve their competence

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in integrating various disciplines (Dhewantoro, 2018). Second, the provision of adequate resources, including relevant teaching materials and teaching aids, is necessary to support the implementation of this method (Meier et al., 1998). Third, the development of a flexible curriculum can provide space for the exploration of cross-disciplinary concepts without being hampered by strict time constraints (Jonker et al., 2020). Fourth, the establishment of learning communities between teachers from different disciplines to encourage ongoing collaboration and exchange of ideas (Kelley & Curtis, 2023). Fifth, the implementation of teaching strategies that facilitate students' transition from traditional learning to integrative approaches is essential (Paramythis & Cristea, 2008).

Learning mathematics based on the unity of sciences at MA Yaspia Ngroto Gubug Grobogan is very important because it can integrate various disciplines, make learning more relevant and interesting, and create a more dynamic and interactive learning environment. This approach makes students better understand how mathematical concepts are applied in various fields, thus increasing the relevance and attractiveness of the subject matter (Radiusman, 2020). However, the main challenges faced in implementing this method include teacher competence (Dhewantoro, 2018), resource limitations (Meier et al., 1998), curriculum limitations (Jonker et al., 2020), and student adaptation to the new approach (Paramythis & Cristea, 2008). Teachers need to have adequate skills and knowledge to integrate concepts across disciplines (Dhewantoro, 2018), while the necessary resources, such as interdisciplinary teaching materials and teaching aids, are often limited (Meier et al., 1998). In addition, strict curricula focused on traditional learning can hinder the flexibility required for this approach (Jonker et al., 2020). Students also need to adapt to more complex learning methods that demand active engagement (Paramythis & Cristea, 2008). Overcoming these challenges is essential to maximize the potential of unity of sciences-based learning so that it can provide optimal benefits for students and improve the quality of education in schools.

To overcome the main challenges in learning mathematics based on the unity of sciences at MA Yaspia Ngroto Gubug Grobogan, it is very important to implement the following strategies to achieve optimal results. First, intensive and continuous training for teachers is needed to improve their competence in integrating various disciplines (Dhewantoro, 2018). Second, the provision of adequate resources, such as interdisciplinary teaching materials and relevant teaching aids, is key to supporting an effective learning process (Meier et al., 1998). Third, flexible curriculum development provides space for the exploration of interdisciplinary concepts without being hampered by strict time constraints (Jonker et al., 2020). Fourth, the establishment of learning communities between teachers from different disciplines encourages collaboration and continuous exchange of ideas, enriching teaching approaches (Kelley & Curtis, 2023). Fifth, the implementation of teaching strategies that facilitate students' transition from traditional learning to integrative approaches helps them adjust to this new method (Paramythis & Cristea, 2008).

The unity of sciences-based mathematics learning at MA Yaspia Ngroto Gubug Grobogan shows conformity with the indicators of Jean Piaget's Cognitive Development Theory. Piaget emphasized the importance of stages of cognitive development where students learn through direct experience and interaction with their environment (Piaget, 1952). First, integrating various disciplines in mathematics learning is in line with Piaget's concept of constructivism, where students construct new knowledge based on existing schemas (Fosnot, 2013). Second, by making learning more relevant and engaging, this approach supports students' concrete and formal operational stages, where they can relate abstract mathematical concepts to real and relevant situations, improving understanding and practical application (Harefa, 2023). Third, creating a more dynamic and interactive learning environment encourages students to be active in the learning process, according to Piaget's idea that learning is an active and social process (Oktavia, 2021). Interdisciplinary interaction also facilitates the development of critical thinking and problem-solving skills, which are key in the formal operational stage (Simanjuntak & Sudibjo, 2019). Therefore, the unity of sciences approach not only enriches learning content but also supports students' cognitive development by the principles outlined by Jean Piaget.

The main challenge in learning mathematics based on the unity of sciences at MA Yaspia Ngroto Gubug Grobogan is closely related to the indicators of Jean Piaget's Theory of Cognitive Development. The challenge of teacher competence in integrating various disciplines reflects the need for teachers to develop new schemas and in-depth knowledge of various fields, in line with Piaget's principles of assimilation and accommodation (Oktavia, 2021; Piaget, 1952). Resource challenges, including limited teaching tools and materials, hinder students' opportunities to experience concrete learning that supports their concrete operational stage (Harefa, 2023). A rigid curriculum goes against students' need to learn through exploration and manipulation of their environment, which is central to cognitive development according to Piaget (Rini et al., 2023). Meanwhile, students' adaptation challenges in shifting to an interdisciplinary approach reflect their difficulties in reaching the formal operational stage, where they should be able to think abstractly and connect concepts from different disciplines (Simanjuntak & Sudibjo, 2019). Therefore, to support students' cognitive development according to Piaget's theory, it is necessary to improve teachers' competencies, provide adequate resources, and develop a flexible curriculum, and teaching strategies that help students adapt to new learning methods (Fosnot, 2013). By addressing these challenges, learning can become more effective and in line with the needs of students' cognitive development.

Strategies to overcome the main challenges in learning mathematics based on the unity of sciences at MA Ngroto Gubug Grobogan are in line with the indicators of Jean Piaget's Theory of Cognitive Development. Intensive and continuous training for teachers supports them in expanding cognitive schemas and developing teaching strategies that assimilate and accommodate, in line with students' stages of cognitive development (Oktavia, 2021; Piaget, 1952). The provision of adequate resources, such as teaching aids and interactive teaching materials, allows students to learn through concrete experiences, which is important for the concrete operational stage (Harefa, 2023). Flexible curriculum development allows for the customization of teaching materials to the needs and cognitive development level of students, supporting learning through exploration and manipulation of their environment (Rini et al., 2023). The formation of learning communities between teachers from different disciplines encourages the exchange of ideas and best practices, which can improve the quality of teaching interdisciplinary concepts effectively, helping students reach the formal operational stage (Simanjuntak & Sudibjo, 2019). The implementation of teaching strategies that facilitate student transitions, such as the use of problem-based projects and case studies, supports the development of abstract thinking and the ability to connect concepts from different disciplines (Winarti et al., 2018). Thus, these strategies not only address challenges in learning but also support students' cognitive development by Piaget's theory, creating a dynamic and effective learning environment.

The findings in this study show similarities with the research Dhewantoro (2018) which explains that the main challenges in the unity of science learning include teacher competence that must master various disciplines, limited resources to support interdisciplinary teaching methods (Meier et al., 1998), a curriculum that must be flexible to accommodate holistic approaches (Jonker et al., 2020), and student adaptation to more complex and integrative learning methods (Paramythis & Cristea, 2008). These challenges are in contrast to traditional learning which typically only requires specialization in one discipline, has more standardized resources, and uses less flexible curricula and more conventional teaching methods. However, the findings of this study contradict (Wang & Sshmidt, 2001) Who states that students often perceive the integration of mathematics with science as difficult and confusing, which can reduce their interest in learning. They found that the complexity of combining concepts from these two disciplines often overwhelms students, especially if they are not familiar with interdisciplinary learning approaches. This difficulty can lead to reduced motivation and engagement in the learning process, hindering their understanding of the material.

To overcome these problems, schools and the government must take several strategic policies. First, intensive and continuous training for teachers is essential to improve their competence in integrating various disciplines into mathematics learning (Dhewantoro, 2018). Second, the provision of adequate resources, including relevant teaching materials, teaching aids, and educational technology, should be a priority (Meier et al., 1998). Third, the development of a flexible and adaptive curriculum

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that facilitates the process of integrating concepts from various disciplines must be implemented (Jonker et al., 2020). Fourth, the formation of learning communities among teachers from different disciplines should be encouraged to facilitate collaboration and exchange of ideas (Kelley & Curtis, 2023). Finally, teaching strategies that facilitate students' transition to the unity of sciences approach, such as the use of interactive and contextual methods, should be introduced and widely implemented (Paramythis & Cristea, 2008). With these policies, it is hoped that the challenges in the unity of science learning can be minimized, thus creating a more dynamic and meaningful learning environment for students.

CONCLUSION

This study found that the unity of sciences-based mathematics learning has significant benefits, such as integrating various disciplines, making learning more relevant and interesting, and creating a dynamic and interactive learning environment. Students who learn with this approach can see real applications of mathematical concepts in other disciplines, thus increasing their interest and motivation. However, some key challenges need to be overcome, namely teacher competence, limited resources, a less flexible curriculum, and student adaptation to new learning methods. To overcome these challenges, some of the strategies taken are intensive and continuous training for teachers to improve their competencies, provision of adequate resources, development of a flexible curriculum, establishment of inter-teacher learning communities from various disciplines, and implementation of teaching strategies that facilitate students' transition from traditional learning to integrative approaches. This study only relied on interviews from five respondents which led to some limitations in the study. The main limitation is the lack of generalizability of the results, as the data obtained only represents the experiences and views of one school and a small number of respondents. This may limit the understanding of the implementation of unity of sciences-based mathematics learning in a broader context. In addition, the interview method with a limited number of respondents is not sufficient to capture the various perspectives and nuances that exist in different educational environments. For future research, it is recommended to expand the scope of the study by involving more schools and respondents from different regions. The use of more diverse research methods, such as quantitative surveys, classroom observations, and in-depth case studies, could also provide richer and more comprehensive data. By involving more participants and using diverse methodological approaches, future research can provide a more accurate and comprehensive picture of the implementation and effectiveness of unity of sciences-based mathematics learning, as well as identify implementations that were not detected in this study.

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