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Development of RTGraph digital books for the topic of Network in Graph Theory in Mathematics Form 4: a needs analysis

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Abstract: This study aimed to examine the need for RTGraph digital books development for the topic of Network in Graph Theory in Mathematics Form 4. This needs analysis was conducted to identify the form of existing teaching and learning materials, software materials, digital books, and ready-to-use applications, and study readiness to use RTGraph digital books for the topic of Network in Graph Theory in Mathematics Form 4. A total of 10 Form Mathematics teachers in Pasir Mas district were answered the questionnaire. The results of the need analysis found that the need for digital books as teaching aids in the teaching and learning process showed that the construction of digital books for the topic of Network in Graph Theory in Mathematics Form 4 is desirable. Therefore, it is hoped that the development of the RTGraf digital book can improve the teaching process of Form 4 mathematics teachers and student learning.

Keywords: needs analysis; RTGraph digital books; network in Graph Theory; teaching and learning.

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1 Introduction

The Malaysian Education Development Plan (MEDP) 2013–2025 is a comprehensive development framework and a transformation of the education system. MEDP has set 11 displacements to achieve the vision of improving education standards in the 21st century. The 7th displacement is to leverage on Information and Communication Technology (ICT) and it was built to improve the quality of education in Malaysia (Ministry of Education Malaysia, 2013).

One of the few transformations is that the Curriculum Development Division has provided guidelines regarding the mathematics curriculum in the implementation of the Secondary School Standard Curriculum (SSSC). Based on Standard Curriculum and Assessment Document (DSKP), the objective of SSSC is to form individuals who are mathematically, creatively and innovatively and capable of effectively applying knowledge and mathematics skills and are responsible in solving problems and decision making, based on attitudes and values in order to overcome the challenges in daily life, in line with the development of science and technology and the challenges of the 21st century.

SSSC Mathematics is one of the core subjects taught at the school level. The process of teaching and learning Mathematics is a difficult process as it covers a wide field and touches on various aspects such as understanding abstract concepts, problem solving application visualisation and modelling (Jumiran, 2014). Studies on students' perception of mathematics have found that students classify Mathematics as one of the difficult subjects (Watson and Gable, 2013). This is because subjects are abstract and require diversity in delivering their content (Gellert et al., 2013). Not all students have the same ability to understand the concepts of Mathematics based on textbook content (Weinberg and Wiesner, 2010).

One of the topics that is often a problem for secondary school students who age 16 years old is the topic of Network in Graph Theory in Mathematics Form 4. It is a new mathematical syllabus in the DSKP for the Secondary School Standard Curriculum (SSSC) for Form 4 students. The topic of Graph Theory is not something new as it has been taught to students related to the basics of graphs before and there have been previous studies related to Graph Theory. In mathematics, graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. Daniel and Taneo (2019) study showed that students had difficulty solving problems in Graph Theory. In addition, studies on Johar and Lubis (2018) found that students are weak in making representations to other forms of representation such as visual to verbal, visual to symbol, visual to visual and verbal to visual. This causes student's interest in learning mathematics to be low.

Teachers need to have knowledge of the pedagogical content of the 21st century because in the classroom, teachers play an active role in the teaching and learning (T&L) process to change the behaviour of students (Abdullah, 2019). 21st century pedagogy contains eight main components, including collaborative learning, technology advancement, problem-solving skills development, project-based learning, optimising ICT as an information source, promoting reflection practices, developing thinking and assessment skills (Abdullah, 2019). In the 21st century, teachers need to constantly reflect pedagogy implemented in the classroom in order to be consistent with T&L which

provides students in a complex and dynamic world influenced by globalisation and digital technology revolution (Abdullah, 2019).

Be aware of the changes in the current education system that requires teachers to make changes in their teaching methods, information technology methods in the T&L process should be used to improve the level of skills of teachers conveying something especially learning through digital textbooks in teaching (Zarwawi, 2015). However, there are still teachers who tend to use traditional methods as the main medium of teaching and learning which causes students to feel bored when teachers practice one-way teaching which does not give the students the opportunity to express their opinions (Fadzilah, 2017). According to Zarwawi (2015), prospective teachers need to be exposed to the process of improving their knowledge and technology skills in learning and teaching while attending their respective institutions in order to improve the skills of future teachers in their subjects using technology as a teaching aids when teaching later.

Learning through digital books should be further enhanced by producing quality educators (Zarwawi, 2015). Hence, a need analysis should be conducted to identify the existing forms of teaching and learning materials, software materials, digital books and ready-to-use applications, and the readiness of the use digital books in the topic of Network in Graph Theory in Mathematics Form 4 before RTGraph digital books are developed.

2 Research objective

This study aims to study the need for the development of RTGraph digital books for the topic of Network in Graph Theory in Mathematics Form 4. Specifically, the objectives of this study are as follows:

- 1 Identify the existing forms of teaching and learning materials in the topic of Networks in Graph Theory in Mathematics Form 4.
- 2 Identify software materials, digital books and ready – to – use applications in the topic of Networks in Graph Theory in Mathematics Form 4.
- 3 To study the readiness of the use of digital books in the topic of Networks in Graph Theory in Mathematics Form 4.

3 Research methodology

This study uses Design and Development Research (DDR). In this study, needs analysis is the first phase in DDR. A needs analysis was made to obtain feedback from Form 4 Mathematics teachers in the Pasir Mas district on the need to develop RTGraf digital books. The population of this study is 103 secondary school Mathematics teachers in Pasir Mas district. Pasir Mas district was chosen because it is close the researcher's residence and this makes it easier for the researcher to collect data. The sampling technique used is simple random sampling by selecting respondents who teach Form 4 Mathematics in Pasir Mas district only. The needs analysis sample in this study involved

10 Form 4 Mathematics teachers in Pasir Mas district. The reason the researcher chose 10 respondents is because in Malaysia implemented the Movement Control Order to deal with the spread of the COVID-19 pandemic. Therefore, researchers have difficulty finding many respondents online.

The instrument used in this study is a modified questionnaire from Hanani (2019). The questionnaire consists of two sections which can be seen in Table 1.

Table 1 Part of the questionnaire

| <i>Part</i> | <i>Components</i> |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| A | Demographic information |
| B (I) | Forms of existing teaching and learning materials in the topic of Networks in Graph Theory in Mathematics Form 4 |
| B (II) | Software, digital books, software applications, and ready-to-use teaching aids for the topic of Networking in Graph Theory in Mathematics Form 4 |
| B (III) | Readiness to teach using digital books in the topic of Networks in Graph Theory in Mathematics Form 4 |

Section B (III) uses a five-point Likert scale as shown in Table 2.

Table 2 Likert scale of five points

| <i>Scale</i> | <i>Statement</i> |
|--------------|-------------------|
| 1 | Strongly disagree |
| 2 | Disagree |
| 3 | Less disagree |
| 4 | Agree |
| 5 | Strongly agree |

The validity of the needs analysis questionnaire of this study refers to three experts consisting of mathematics teachers who have had more than 10 years of experience teaching mathematics. The validity involved is content validity, construct validity and face validity. This questionnaire is given to a panel of experts on the validity of the questionnaire instrument to be evaluated and agreed upon. Based on expert comments and opinions, the questionnaire was improved by rearranging, replacing and improving some items. The reliability of this questionnaire instrument was made by taking the Cronbach's alpha value recommended by Pallant (2010). The Cronbach's alpha reliability value of this study is 0.762, so it has a high reliability index scale. Therefore, it can be concluded that this research instrument is suitable and reliable to obtain valid research results.

Descriptive analysis used to analyse the data obtained. Demographic analysis of respondents (Part A), analysis of forms of teaching and learning materials available in the topic of Networks in Graph Theory in Mathematics Form 4 (Part B (I)), and analysis of software, digital books, software applications, and ready -to -use teaching aids for the topic of Networks in Graph Theory in Mathematics Form 4 are made by showing

frequency and percentage while analysis of teaching readiness using digital books in the topic of Network in Graph Theory in Mathematics Form 4 (Part B (III)) is made by showing the mean values. Table 3 showing interpretation of the mean score values used for Part B (III) in this study.

Table 3 Interpretation of mean score values

| <i>Stage</i> | <i>Mean score interpretation</i> |
|--------------|----------------------------------|
| 3.68–5.00 | High |
| 2.34–3.67 | Medium |
| 1.00–2.33 | Low |

4 Findings and discussions

Based on the needs analysis questionnaire, there is a need to develop RTGraph digital book for the topic of Networks in Graph Theory in Mathematics Form 4.

4.1 Respondent demographics

A total of 10 Form 4 Mathematics teachers in Pasir Mas district answered the questionnaire. Demographics of the respondents are shown in Table 4.

Table 4 Demographics of respondents

| <i>Aspects</i> | <i>Categories</i> | <i>Frequency (%)</i> |
|----------------------|--------------------------|----------------------|
| Gender | Male | 4 (40.0) |
| | Female | 6 (60.0) |
| Service period | 5 years and below | 0 (0.0) |
| | 6–10 years | 0 (0.0) |
| | 11–15 years | 1 (10.0) |
| | 16–20 years | 6 (60.0) |
| | 21–30 years | 2 (20.0) |
| | 31 years and above | 1 (10.0) |
| Positions in schools | Academic teachers | 10 (100.0) |
| | Head panel | 0 (0.0) |
| | Senior Assistant Teacher | 0 (0.0) |

Table 4 showed 10 respondents that the number of female teachers exceeds male teachers where 4 male teachers and 6 female teachers were involved in this study. In addition, 10 respondents of this study had an experience of teaching more than 15 years. All respondents were regular academic teachers.

4.2 Existing forms of teaching and learning materials in the topic of Network in Graph Theory in Mathematics Form 4

Analysis of existing form of teaching materials and learning materials in the topic of Network in Graph Theory in Mathematics Form 4 is shown in Table 5.

Table 5 Analysis of existing forms of teaching and learning materials in the topic of Networks in Graph Theory in Mathematics Form 4

| <i>No.</i> | <i>Item</i> | <i>Categories</i> | <i>Frequency (%)</i> |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------|
| 1 | What forms of teaching materials are used by teachers to teach the topic of Networks in Graph Theory? | Printed modules/ Notes/ Reference books | 5 (50.0) |
| | | Power point slides | 3 (30.0) |
| | | Online Software Applications | 2 (20.0) |
| | | Digital Books | 0 (0.0) |
| 2 | Do you use the following Information and Communication Technology (ICT) facilities to help students understand the topic of Networks in Graph Theory? | Online interactive multimedia software | 4 (40.0) |
| | | Discussion rooms on the internet | 0 (0.0) |
| | | Access to educational websites | 6 (60.0) |
| | | Digital Books | 0 (0.0) |
| 3 | Have you ever used the facilities of Information and Communication Technology (ICT) to solve problems in the topic of Networks in Graph Theory? | Yes | 10 (100.0) |
| | | No. | 0 (0.0) |
| 4 | If Yes, what software applications, or teaching aids have you used to solve problems in the topic of Networks in Graph Theory | Geometer's Sketchpad (GSP) | 6 (60.0) |
| | | Geogebra | 4 (40.0) |
| | | Gelphi | 0 (0.0) |

Based on Table 5, there is still no digital books-shaped teaching materials used by teachers to teach the topic of Networks in Graph Theory. In addition, no teacher uses ICT facilities in the form of digital books to help students understand the topic of Networks in Graph Theory. However, 100% of teachers have used ICT to solve problems in the topic of Networks in Graph Theory. Some 60% of teachers use Geometer's Sketchpad (GSP) and 40% of teachers use Geogebra to solve problems in the topic of Networks in Graph Theory. This shows the teachers in the district of Pasir Mas lacking online teaching aids. Therefore, there is a need to develop RTGraph digital book for the topic of Networks in Graph Theory in Mathematics Form 4.

4.3 Software, digital books, software applications, and ready-to-use teaching aids for the topic of Network in Graph Theory in Mathematics Form 4

Analysis of software, digital books, software applications, and ready-to-use teaching aids for the topic of Network in Graph Theory in Mathematics Form 4 are shown in Table 6.

Table 6 Software, digital books, software applications, and ready-to-use teaching aids for the topic of Network in Graph Theory in Mathematics Form 4

| No. | Item | Yes | | No. | |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|-------|
| | | F | % | F | % |
| 1 | Is the content of the teaching materials used by teacher interactive? | 2 | 20.0 | 8 | 80.0 |
| 2 | Do the teaching materials used by teachers strengthening students' understanding of the topic of Networks in Graph Theory? | 3 | 30.0 | 7 | 70.0 |
| 3 | Do you use teaching materials for the topic of Networks in Graph Theory with digital books, applications, learning software or online websites? | 8 | 80.0 | 2 | 20.0 |
| 4 | If Yes, does the teaching material meets the topic of Networks in Graph Theory (covering the entire subtopics in the topic)? | 0 | 0.0 | 10 | 100.0 |
| 5 | Does the content of the application, digital book or software meets and help to solve all problems in each subtopic in the topic of Networks in Graph Theory? | 6 | 60.0 | 4 | 40.0 |
| 6 | Are existing applications, digital books or software for the topic of Networks in Graph Theory is simply available and understood? | 2 | 20.0 | 8 | 80.0 |
| 7 | Do you use applications, digital books or software local (Malaysian product) for teaching and learning for the topic of Networks in Graph Theory? | 0 | 0.0 | 10 | 100.0 |
| 8 | Is there an existing application, digital book or software that contains note information and question exercises specifically for the topic of Networks in Graph Theory? | 0 | 0.0 | 10 | 100.0 |
| 9 | Do you have to find various types of applications, digital books or software to solve all the problems in the topic of Networks in Graph Theory? | 8 | 80.0 | 2 | 20.0 |
| 10 | Do you use software, digital books or software applications for the topic of Networks in Graph Theory that can be installed on your computer and can be used at anytime and anywhere? | 3 | 30.0 | 7 | 70.0 |

Based on Table 6, 80% disagreed that the content of the teaching materials once used by the teacher was interactive. Only 30% of teachers said the teaching materials used by teachers strengthened the students' understanding. A total of 80% of teachers said they had used teaching materials for the topic of Networking in Graph Theory with digital

books, applications, learning software or online websites. However, teachers unanimously stated that the teaching materials did not meet the overall subtopics in the topic of Networks in Graph Theory. In addition, 60% of teachers state the contents of application, digital books or software help in solving all problems in each subtopic in the topic of Networks in Graph Theory. However, only 20% of teachers state existing applications, digital books or software for the topic of Networks in Graph Theory are easily available and understandable. 100% teachers do not use applications, digital books or local software (Malaysian products) and all teachers admit that there are no applications, digital books, or especially available software for the topic of Networks in Graph Theory. 80% of teachers said they needed to find a wide range of applications, digital books or software to solve all problems in the topic of Networks in Graph Theory.

The findings also show that only 30% of teachers are ready to use digital books installed on the computer and used at any time. This may be because teachers have not been exposed to the use of digital books that could improve their teaching process. Therefore, teachers also need to learn for themselves how to use all these websites, applications, digital books and software this to enable themselves to use this digital books and help solve all the problems in each subtopic in the topic of Networks in Graph Theory. The diversity of methods they need to explore, every website, application, digital book and the software has different methods and methods require high skill in its use. The process of learning to use it is also influencing a long time for teachers to learn and understand the use of such websites, applications, digital books and software. The findings of this study also indicate that claim on digital books are appropriate. Hence, with RTGraph digital book usage, students only need to focus on one digital book that includes simple and complete information that includes all subtopics in the topic of Networks in Graph Theory.

4.4 Readiness to teach using digital books in the topic of Networks in Graph Theory in Mathematics Form 4

Analysis of teaching readiness using digital books in the topic of Networks in Graph Theory in Mathematics Form 4 is shown in Table 7.

Based on the findings of the study in Table 7, medium mean score value demonstrating the readiness of mathematics teachers to teach using digital books in the topic of Network in Graph Theory in Mathematics Form 4 i.e., they are ready to teach using digital books anytime and anywhere. The development of digital books should emphasise the readiness of teachers so that digital books are developed according to space and opportunity. In this case, the researcher believes that the teacher's readiness in the use of digital books in the medium stage as they may not have been exposed and introduced again with a complete digital book with learning modules that meet the requirements for the topic of Network in Graph Theory in Mathematics Form 4. The findings of this study are also in parallel with a study of Hanani (2019), Farah et al. (2019) and Farah and Hanani (2019).

Table 7 Readiness to teach using digital books in the topic of Networks in Graph Theory in Mathematics Form 4

| <i>No.</i> | <i>Item</i> | <i>Mean</i> | <i>Interpretation</i> |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------|
| 1 | I'm ready to use digital books for the topic of Networks in Graph Theory at any time | 3.00 | Medium |
| 2 | I'm ready to use digital books as one of the teaching aids in teaching and learning sessions for the topic of Networks in Graph Theory | 2.80 | Medium |
| 3 | I'm always ready to learn how to use digital books for the topic of Networks in Graph Theory | 2.50 | Medium |
| 4 | I have skills using digital books as teaching materials for the topic of Networks in Graph Theory | 2.50 | Medium |
| 5 | I don't face any obstacles using the digital book for the topic of Network in Graph Theory | 2.80 | Medium |
| 6 | I'm ready to face challenges in using digital book for the topic of Network in Graf Theory | 2.60 | Medium |
| 7 | I'm sure digital books help to improve my students' understanding in topic of Network in Graph Theory | 3.00 | Medium |
| 8 | I'm sure my students can solve problems in topic of Network in Graph Theory with the help of existing applications, digital books and learning software | 3.00 | Medium |
| 9 | I'm sure digital books can improve the achievement in academics of my students for the topic of Network in Graph Theory | 2.70 | Medium |

5 Conclusion

The needs analysis phase should be implemented as the first step in the Design and Development Research (DDR). The needs analysis is very important to identify the existing forms of teaching and learning materials, software materials, digital books and ready-to-use applications, and the readiness of the use digital books in the topic of Network in Graph Theory in Mathematics Form 4 before RTGraph digital books are developed. Based on the needs analysis that have been carried out, the need for digital books as teaching materials in T&L shows that digital book development for the topic of Network in Graph Theory in Mathematics Form 4 is reasonable.

The findings of this study show that there are still no digital books-shaped teaching materials used by teachers to teach the topic of Networks in Graph Theory. This shows the teachers in the district of Pasir Mas lacking online teaching aids. The findings also show that medium mean score value demonstrating the readiness of mathematics teachers to teach using digital books in the topic of Network in Graph Theory in Mathematics Form 4 i.e., they are ready to teach using digital books anytime and anywhere. In this case, the researcher believes that the teacher's readiness in the use of digital books in the medium stage as they may not have been exposed and introduced again with a complete digital book with learning modules that meet the requirements for the topic of Network in Graph Theory in Mathematics Form 4.

In conclusion, there is a need to develop RTGraph digital book for the topic of Networks in Graph Theory in Mathematics Form 4. It is hoped that the development of the RTGraf digital book can improve the teaching process of Form 4 mathematics teachers and student learning. Further studies can be carried out qualitatively on the needs analysis phase to obtain detailed information related about the need for digital books as teaching materials in T&L.

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