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DEVELOPMENT AND USABILITY OF 'CellSplit Insight' E-LEARNING TOOL ON THE TOPIC OF CELL DIVISION FOR FORM 4 BIOLOGY

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ABSTRACT

The research project aims to develop an e-learning tool named 'CellSplit Insight' with strong validity and assess its usability for teaching cell division in Form 4 Biology. Using a quantitative approach, the tool was developed following the ADDIE model, and its usability was assessed using the USE questionnaire adapted from Lund (2001). The study employed simple random sampling to select 37 students for the pilot test and 77 students for the field test across schools in Malacca. Expert validity, pilot testing, and field testing were conducted to evaluate the tool's validity, reliability, and usability. Data analysis methods included the Content Validity Index (CVI) for expert validity, Cronbach's Alpha for pilot testing, and descriptive analysis (mean and standard deviation) for field testing. Results indicated high validity with a CVI value of 1.0. Usability scores were also favourable across all constructs: usefulness (mean: 3.7857, sd: 0.37547), ease of learning (mean: 3.7857, sd: 0.32987), ease of use (mean: 3.7890, sd: 0.38274), and satisfaction (mean: 3.8182, sd: 0.31580), resulting in an overall high usability rating (mean: 3.7946, sd: 0.2912). The development of the CellSplit Insight e-learning tool has positive implications for both students and teachers. It enhances student learning by improving comprehension particularly in complex topics like cell division. It supports a pedagogical shift towards more student-centred learning and facilitating a blended learning environment. Additionally, the findings also emphasize the importance of integrating advanced technologies into education, highlighting that similar tools could be beneficial for teaching other complex topics within the Form 4 Biology syllabus. Recommendations for future works include adding language options, integrating advanced technologies like AR and VR for a richer experience, expanding content coverage, and replicating the study in other regions for broader insights.

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ABSTRAK

Projek penyelidikan ini bertujuan membangunkan alat e-pembelajaran 'CellSplit Insight' dengan kesahan yang tinggi dan menilai kebolehgunaannya untuk pengajaran pembahagian sel dalam Biologi Tingkatan 4. Melalui pendekatan kuantitatif, alat ini dibangunkan mengikut model ADDIE, dan kebolehgunaannya dinilai menggunakan soal selidik USE yang diadaptasi daripada Lund (2001). Kajian ini memilih 37 pelajar untuk ujian rintis dan 77 pelajar untuk ujian lapangan di sekolah-sekolah Melaka melalui persampelan rawak mudah. Ujian kesahan pakar, ujian rintis, dan ujian lapangan menilai kesahan, kebolehpercayaan, dan kebolehgunaan alat ini. Kaedah analisis data termasuk Indeks Kesahan Kandungan (CVI) untuk kesahan pakar, Alpha Cronbach untuk ujian rintis, dan analisis deskriptif (min dan sisihan piawai) untuk ujian lapangan. Keputusan menunjukkan kesahan tinggi (CVI: 1.0) dan skor kebolehgunaan yang memuaskan bagi semua konstruk: kegunaan (min: 3.7857, sp: 0.37547), kemudahan pembelajaran (min: 3.7857, sp: 0.32987), kemudahan penggunaan (min: 3.7890, sp: 0.38274), dan kepuasan (min: 3.8182, sp: 0.31580), dengan penilaian kebolehgunaan keseluruhan yang tinggi (min: 3.7946, sp: 0.2912 Pembangunan 'CellSplit Insight' memberi kesan positif kepada pelajar dan guru dengan memperbaiki pemahaman topik kompleks seperti pembahagian sel, menyokong peralihan ke pembelajaran berpusatkan pelajar, dan memudahkan pembelajaran gabungan. Selain itu, dapatan kajian juga menekankan kepentingan mengintegrasikan teknologi ke dalam pendidikan, menunjukkan bahawa alat serupa boleh memberi manfaat dalam pengajaran topik-topik kompleks lain dalam silibus Biologi Tingkatan 4. Cadangan termasuk menambah pilihan bahasa, mengintegrasikan teknologi maju seperti AR dan VR untuk pengalaman yang lebih kaya, memperluaskan liputan kandungan, dan mengulang kajian di kawasan lain untuk mendapatkan pandangan yang lebih luas.

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LIST OF ABBREVIATION

Abbreviation	Definition
CVI	Content Validity Index
DKSP	Dokumen Standard Kurikulum dan Pentaksiran
FPK	Falsafah Pendidikan Kebangsaan
IoT	Internet of Things
KBSM	Kurikulum Bersepadu Sekolah Menengah
KPM	Kementerian Pendidikan Malaysia
KSSM	Kurikulum Standard Sekolah Menengah
NEP	National Education Philosophy
PPPM	Pelan Pembangunan Pendidikan Malaysia
SPM	Sijil Pelajaran Malaysia
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, Engineering, Mathematics
WBLE	Web-based Learning Environment

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CHAPTER 1

INTRODUCTION

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1.1 Introduction

This chapter discusses about the background of the research, the statement of the research problem, the research objectives, the research questions, the research significance, the research limitations, the conceptual framework of the research, and the operational definition which explains the terms related to the research title.

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1.2 Research Background

When the crucial role played by education in the development of a country is the topic of the discussion, the discussion is not solely about the education itself but we are literally discussing a powerful engine which drives vigorous development in multiple fields. In other words, education is not only a ladder for an individual to pursue knowledge but also an indispensable driving force for the entire country to move forward.

The education system of a country is complicated as it consists of many subsystems and components which interact with each other. A successful education system can be achieved only when all components are interconnected and support each other (Zaini bin Abdullah, 2021). A complete and effective education system requires the national philosophy of education as the framework and education policy as the cornerstone. According to Zaini (2021), the broad idea or framework of thought that should be applied to education is embodied in the philosophy of education, and the education policies are formulas that are adopted by which the goals found in the education philosophy are brought to fruition. Although the philosophy, policy and education system are perceived differently and serve different purposes, their implementation is one. In order to administer ideal education and accomplish the intended aim, three of them are interconnected (Zaini, 2021).

The National Education Philosophy (FPK) of Malaysia which was officially formed in 1988 according to the needs of Malaysian and the citizens is aim to nurturing well-rounded individuals who is highly involved in all aspects such as intellectually,

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spiritually, emotionally, physically balanced and harmonious based on a firm belief in and devotion to God by fully developing the potential of individuals in a holistic and integrated manner (Kementerian Pendidikan Malaysia, 2017). Based on the NEP, the Ministry of Education Malaysia (KPM) had formulated the education policy which was adopted throughout the education system in Malaysia. The education policy of Malaysia is comprehensive and dynamic which is in line with current changes and developments.

The Ministry of Education Malaysia has formed and released the Malaysian Education Blueprint (PPPM) 2013-2015 which aims to evaluate the existing Malaysia education system performance in comparison to worldwide benchmarks while taking historical starting points into account in 2013. The Malaysian Education Blueprint (PPPM) 2013-2015 emphasised the STEM education which is based on four disciplines namely Science, Technology, Engineering, and Mathematics as one of the agenda that needs to be implemented in the education system (Siti Hamizah Aspin, Marlina Ali & Muhammad Abd Hadi Bunyamin, 2022). Science and technology are the core of national development. Therefore, STEM education should be emphasised and implemented in the education system. It is worth mentioning that science is the origin of modern technology and it greatly contributes to today's technological development.

According to Millar (1991), science has been a difficult subject for students to learn because the content of science is complex and abstract. The process of learning science concepts, theories and principles is challenging because it is difficult for the learners to make sense of the concepts, theories and principles as they are not learned by formulas and calculations (Johnstone, 1991). However, educational technology

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could be the key to the success of science education as it can enhance student's understanding of science concepts greatly. Educational technology may assist science education by taking the difficult to learn science concept and changing it from abstract to concrete so that students can understand it easier (Isman, Yaratan, and Caner, 2007). The Malaysia Education Blueprint (PPPM) 2013-2025 also has emphasised the incorporation of ICT in education to scale up quality learning across Malaysia under Shift 7 in the Malaysia Educational Blueprint.

In Malaysia, biology is one of the subjects that should be taken by every pure science stream student who are Form 4 and Form 5 in every higher secondary school under the government. There are several topics in the syllabus of biology. However, the syllabus of the biology subject is not easy for the student to learn. Biology is a subject that contains many difficult concepts to study (Fauzi, Rosyida, Rohma, and Khoirah, 2021). It is not an easy task for the students to understand the topics of biology and a misconception will often occur when the students try to deal with those.

As mentioned above, an idea of developing an E-learning tool namely, 'CellSplit Insight' to assist student in learning difficult topics such as cell division topic in which the concept of mitosis and meiosis is too abstract and difficult for students to understand was triggered.

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1.3 Problem Statement

Biology is a study of life and living organisms. Learning biology can help us understand nature better. However, biology was considered as a difficult subject to learn. In the past 10 years, many research and studies have been conducted on those topics in biology that students find are most difficult to master worldwide. Cell division almost always appears among the five most difficult topics in biology subject to master in those research, even in the latest five years of local and foreign research. According to the survey research done by Ezechi (2019), which three research questions were formulated to guide the study and the data was collected using structured questionnaire and the collected data were analysed using mean.

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The analysis showed that those items that student rated with mean score below the benchmark of 2.50, indicating these topics were perceived as difficult. Notably, the topic of mitosis and meiosis (item 3) was also considered particularly difficult, with a mean score of 2.03, significantly below the mean benchmark of 2.24. Conversely, the rest items received with mean scores above the 2.50 cut off, suggesting that student found these topics is easier. This revealed that mitosis and meiosis were perceived as one of the difficult topic to learn by secondary school students.

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Table 1.1

Table of difficult topics in secondary schools biology curriculum as perceived by the students in the research.

Items	Topics in Biology Curriculum	Mean	Remark
1	Mendelian Genetics	2.38	Difficult
2	Genes and chromosomes	2.06	Difficult
3	Mitosis and Meiosis	2.03	Difficult
4	Nervous system	3.00	Not difficult
5	Protein synthesis	2.13	Difficult
6	DNA synthesis	2.23	Difficult
7	Excretory system	2.67	Not difficult
8	Homeostasis	2.10	Difficult
9	Photosynthesis	2.53	Not difficult
10	Enzymes	1.97	Difficult
11	Transport of materials	2.88	Not difficult
12	Ecology	1.97	Difficult
13	Cell and organelles	2.93	Not difficult
14	Evolution	2.11	Difficult
15	Skeletal system	2.14	Difficult
16	Reproduction	2.54	Not difficult
17	Classification	2.04	Difficult
18	Sensory organs	2.56	Not difficult
19	Pollution	2.58	Not difficult
20	Endocrine system	2.20	Difficult
	Grand Mean	**2.24**	**Difficult**

Source. Reprinted from 'Difficult Topics in Secondary School Biology Curriculum as Perceived by Secondary School Students in Ezeagu Local Government Area of Enugu State' by Ezechi, 2019, *International Journal of Engineering & Scientific Research*, 7, p. 56.

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A relevant survey research was carried out to identify the difficult topic in Form 4 biology from both teachers' and students' perspectives by Wan Nasriha, Che Nidzam, and Setyaningsih (2021) in Malaysia also presented that cell division is one of the difficult topic to master in students' perspective. In the research, the Biology Difficult Topics questionnaire was created for data collection and the collected data was processed and analysed descriptively using the application of SPSS. The result presented that cell division was considered second place in the sequence of topic difficulties among eight selected topics in Malaysia Form 4 Biology syllabus from the student's point of view with the mean score of 2.97 and standard deviation of 1.041.

Table 1.2

Table of the sequence of topic difficulties in Form 4 Biology Syllabus from students' point of view

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Topic	Mean score	Standard deviation	Sequence of Difficulty
Nutrition	2.95	.933	1
Cell division	2.97	1.041	2
Chemical composition in cells	3.00	.846	3
Respiration	3.21	.901	4
Dynamic ecosystem	3.33	.936	5
Endangered ecosystem	3.59	.947	6
Movement of substances across the plasma membrane	3.60	.940	7
Cell structure and organisation	3.84	.965	8

Source. Reprinted from 'Difficult Topics in Biology from the View Point of Students and Teachers based on KBSM Implementation' by Wan Nasriha et al., 2021, *EDUCATUM Journal of Science, Mathematics and Technology*, 8, p. 53.

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Newman, Catavero, and Wright (2012) stated that while students typically understand basic chromosome structure, they struggle to explain complex processes like homologous pairing during meiosis. The main difficulty in learning about cell division, particularly meiosis, is due to a lack of knowledge about chromosomes and their significance (William, DeBarger, Montgomery, Zhou, and Tate, 2012). Most of the students rely on memorising the stages of both mitotic and meiotic process and their respective distinguishing attributes but failed to provide a comprehensive synthesis of the process when asked to differentiate how cell division occurs in the organisms (Lopez et al., 2022).

Furthermore, the analysis and finding from Malaysian Examination Syndicate (Lembaga Peperiksaan Malaysia) on the answer given by the students in the Malaysian Certificate of Education examination (SPM) in the topic of cell division supported the statements of students are confusing in differentiate the stages in the process of mitosis and meiosis and struggling to explain the complex process as well as chromosome behaviours in cell division. For instance, the analysis of Biology Paper 2 in the year 2014 shows students' low understanding of the meiosis process in the topic of cell division and they failed to identify and name the particular stage asked in the question in the process of meiosis process. Moreover, students also failed to describe the chromosome behaviour during the particular stage in the cell division process, and it includes students failed to explain the important of the process occurred in cell division by applying the concepts.

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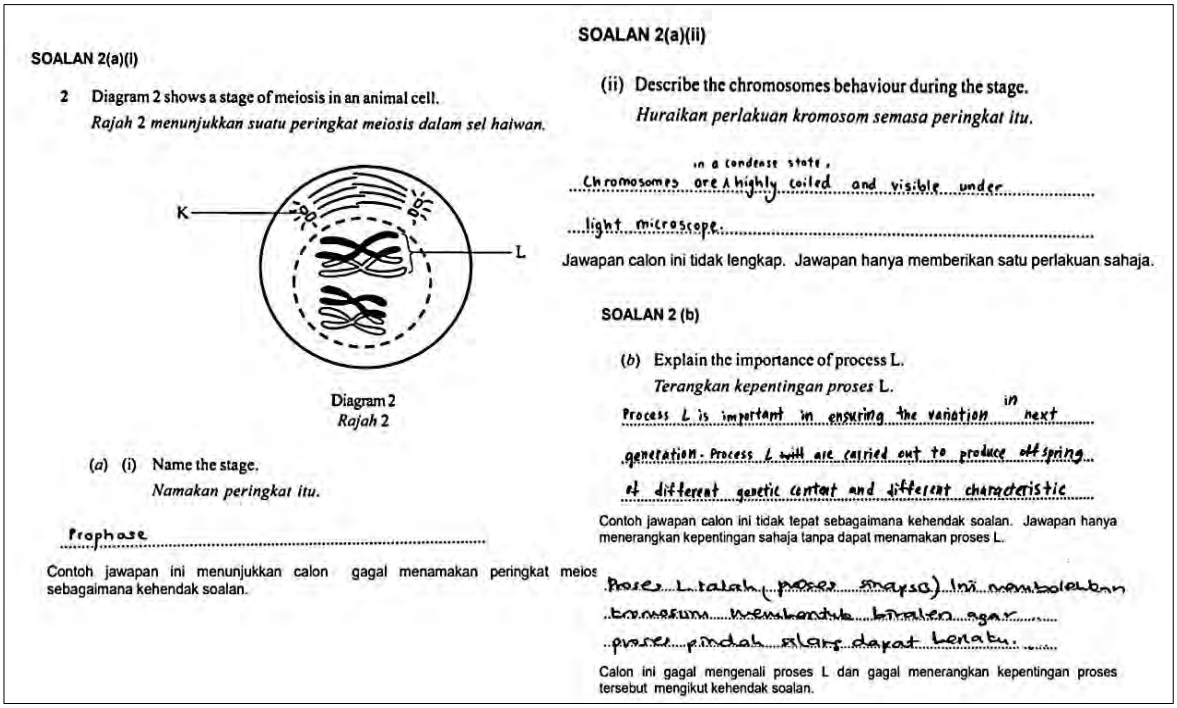

SOALAN 2(a)(i)

2 Diagram 2 shows a stage of meiosis in an animal cell.
Rajah 2 menunjukkan suatu peringkat meiosis dalam sel haiwan.

Diagram 2
Rajah 2

(a) (i) Name the stage.
Namakan peringkat itu.

Prophase

Contoh jawapan ini menunjukkan calon gagal menamakan peringkat meios sebagaimana kehendak soalan.

SOALAN 2(a)(ii)

(ii) Describe the chromosomes behaviour during the stage.
Huraikan perlakuan kromosom semasa peringkat itu.

in a condense state, Chromosomes are highly coiled and visible under light microscope.

Jawapan calon ini tidak lengkap. Jawapan hanya memberikan satu perlakuan sahaja.

SOALAN 2 (b)

(b) Explain the importance of process L.
Terangkan kepentingan proses L.

Process L is important in ensuring the variation in next generation. Process L will are carried out to produce offspring at different genetic content and different characteristic

Contoh jawapan calon ini tidak tepat sebagaimana kehendak soalan. Jawapan hanya menerangkan kepentingan sahaja tanpa dapat menamakan proses L.

Proses L ialah (proses meiosis) ini membolehkan kromosom membentuk kromatin agar proses pindah silang dapat berlaku.

Calon ini gagal mengenali proses L dan gagal menerangkan kepentingan proses tersebut mengikut kehendak soalan.

Figure 1.1. The analysis of students' answers for the cell division topic questions in 2014 SPM examination from Kupasan Mutu Jawapan SPM 2014 Biologi Kertas 2 by Lembaga Peperiksaan Malaysia, 2016.

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The topic of cell division is considered as a difficult topic to master in the perspective of students is reasonable. There are many factors that lead to the difficulties in learning biology as in the perspective of the students. According to the survey research mentioned done by Ezechi (2019) mentioned before, the analysis of the collected data presented that students identified those items which had mean scores above the cut off point of 2.50 are the factors contributing to the difficulty of learning biology and the item with the mean score below the cut toff point of 2.50 was not seen as a contributing factor. Hence, in the perspective of students, the factors that leading to the difficulty in learning biology are insufficient resources, the complexity of the materials and the student's negative attitudes towards challenging topic.

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Table 1.3

Table of factors responsible for the topic difficulties as perceived by secondary school students.

No.	Items	Mean	Remark
1.	No suitable models in school	3.00	Agreed
2.	No suitable text books for effecting teaching and learning of those topics	2.67	Agreed
3.	Terms are too technical and complex and abstract	2.53	Agreed
4	Lack of good instructional materials to drive home the lessons	2.88	Agreed
5.	They are too theoretical and bulky to deal with	3.02	Agreed
6.	No known real life application of these difficult concepts	2.93	Agreed
7.	Complex names, unfamiliar and long names and functions	3.05	Agreed
8.	No internet in school for further research on the difficult topics	2.66	Agreed
9.	Student's poor attitude towards any topic perceived to be difficult	2.99	Agreed
10.	Too many students in the classroom make it difficult for one to concentrate during biology lessons	2.20	Disagreed
	Grand Mean	**2.79**	**Agreed**

Source. Reprinted from 'Difficult Topics in Secondary School Biology Curriculum as Perceived by Secondary School Students in Ezeagu Local Government Area of Enugu State' by Ezechi, 2019, *International Journal of Engineering & Scientific Research*, 7, p. 57.

In the research done by Wan Nasriha et al. (2021), it also aimed to identify the possible reasons that make these topics difficult as perceived by both students and teachers. The analysis of the data collected revealed that the primary factor making biology topics difficult is the complex terminology, which accounted for 57.6%. Other significant factors included difficulty in understanding concepts (18.2%) and the

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abstract nature of the concepts (15.2%). The topic of cell division is particularly challenging due to numerous foreign and complex terms. This often leads students to memorize information without truly understanding it, resulting in misconceptions. Abstract concepts are hard to visualize and teach, making biology challenging and contributing to negative perceptions of the subject. Other contributing factors include issues related to teachers, students, and insufficient learning aids.

Table 1.4

Table of factors of topic difficulty in perceptions of students and teachers.

Factors	**Percentage of agreement (%)**
The concept is too abstract	15.2
The concept is difficult to understand	18.2
There are various terms that are difficult to describe	57.6
Others	9.1

Source. Reprinted from 'Difficult Topics in Biology from the View Point of Students and Teachers based on KBSM Implementation' by Wan Nasriha et al., 2021, *EDUCATUM Journal of Science, Mathematics and Technology*, 8, p. 54.

Many topics in biology subject involves abstracts concepts that cannot be directly observed (Kidman, 2008). Students often struggle in learning the difficult topic because the teaching focuses heavily on textbooks and memorising the Latin terms that lack relevance to everyday life. Students do not like to read textbook as they think textbook often contain complicated contents and less interesting and engaging which leading to a lack of comprehension and motivation to read (Li & Yang, 2023). When teachers rely heavily on textbooks and ask students to focus mainly on reading and

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memorising important points, it can lead to less effective teaching and learning (Hadiprayitno, Muhlis, and Kusmiyati, 2019).

Additionally, the teacher-centred approaches also bring about the difficulty in learning biology subject. However, many teachers prone to adopt the teacher-centred approach rather than focusing on student engagement in the lesson and less to adopt the student-centred approach in the process of teaching and learning. This tends to lower student enthusiasm and engagement in the lessons (Hadiprayitno et al, 2019). Teachers often struggle to adopt a student-centred approach due to a lack of suitable models in schools, inadequate instructional materials, and insufficient learning resources (Ezechi, 2019).

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1.4 Research Objectives

The research objectives of the research are:

1. To develop an e-learning tool on the topic of cell division for Form 4 Biology subject.

2. To determine the usability of the developed e-learning tool on the topic of cell division for Form 4 Biology subject.

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1.5 Research Questions

The research questions of the research project are:

1. Is the CellSplit Insight e-learning tool on the topic of cell division for Form 4 Biology subject has a good validity?

2. What is the usability of CellSplit Insight e-learning tool on the topic of cell division for Form 4 Biology subject?

1.6 Research Significance

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This research project aims to develop an e-learning tool which has the good validity and usability in order to assist students to improve their understanding on the difficult topic of cell division in Form 4 Biology subject. 'CellSplit Insight' E-learning tool was designed based on the Standard Curriculum and Assessment Document (DSKP) which introduced by the Ministry of Education Malaysia (KPM) which aligned with Malaysian Form 4 Biology syllabus and more suitable for the students. The E-learning tool consists of simple and easy to understand notes for students to read and short video explanation to help students understand the cell division concepts easily. Other than that, 'CellSplit Insight' also consist of practice and activities which was designed according to the model of Bloom Taxonomy that could encourage students move through the learning process from the most fundamental level to the more complex level. 'CellSplit Insight' E-learning tool encourage the student-centred learning approach as

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students may use it as a learning tool for self-revision and explore it by themselves without the guidance of the teacher at home. Lastly, the data and the result obtained from this study may also serve as a reference for the Ministry of Education Malaysia (KPM) for the future developments.

1.7 Research Limitations

The final year project has some potential and unavoidable limitations. First and foremost, the scope of the CellSplit Insight only focuses on chapter 6 of the KSSM Form 4 Biology syllabus which is the topic of cell division. Although there are several terms that applied in the cell division will be applied in the other related topic, and cell division is considered as a fundamental of the related topic such as the topic of genetics, but the genetics topic is not included in the scope of the project.

Secondly, the target population involved in this research are the Form 4 biology students from some of the secondary schools, located in the Malacca state. Thus, the data collected is also limited by the perspective of the students in the state of Malacca and the academic performance level of the students in the school, and it is limited to determine the usability of the product for all Form 4 students in Malaysia.

Thirdly, the next possible limitation of CellSplit Insight e-learning tool is the language option limitation as all the instructions, notes and all media in CellSplit Insight are only available in English, there are no other language options provided to the user. Thus, it might be not friendly for the students who learn the syllabus in Bahasa Melayu,

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leading to the failure to provide a good user experience for those students who learn the syllabus in Bahasa Melayu.

1.8 Conceptual Framework

Figure 1.1 shows the conceptual framework that indicates how the final year project will be carried out. The framework integrates several learning theories, including constructivism, cognitivism, connectivism and e-learning theory, alongside the cell division topic in KSSM Form 4 Biology syllabus. Constructivism strongly emphasis on how students actively construct their own knowledge and understanding through experiences and reflection. In order to incorporate this, the e-learning tool offers students the opportunity investigate the construct about cell division through the interesting and hands-on activities.

Cognitivism focuses on the mental processes involved in learning such as perception, memory, and problem-solving. The features like quizzes and puzzles games are included in the e-learning tool to assist students in practicing and reinforcing their understanding of cell division concepts. Next, the learning theory of connectivism highlights the significance of networks and connections in the learning process particularly in this digital age. Thus, the e-learning tool provides a platform for discussion forums through the designated activities to enable students to learn from each other and build connections. E-learning theory integrates various learning theories to optimise learning in online and digital environments, focusing on interactivity, accessibility, and engagement of the students. The e-learning tool consists of

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multimedia elements such as videos, images, animations and mind maps to improve understanding and engagement of students.

All content within the e-learning tool is prepared based on KSSM Form 4 Biology textbook syllabus which aligned with the Standard Curriculum and Assessment Document (DSKP) to ensure it meets educational standards and learning objectives. The selected framework integrates multiple learning theories to address various aspects of the learning process, ensuring a comprehensiveness and effectiveness of the e-learning tool. The combination of constructivism, cognitivism, and connectivism can enhance student engagement and learning outcomes especially in the digital learning environments.

The framework involves the operationalisation of its components through the expert validity for the developed e-learning tool and its content, pilot test for reliability and field test for the usability. Expert validity will assess the face validity and content validity of both developed e-learning tool and the questionnaire. The pilot test with a small group of students will measure the reliability of the developed e-learning tool and the questionnaire, while field test in the actual classroom setting with the target samples will evaluate the overall usability of the e-learning tool in helping students to improve their understanding of the topic of cell division.

This conceptual framework provides a structured approach to developing an e-learning tool that benefit to the students and carry out the developmental research. By grounding the tool in established educational theories and aligning it with the curriculum standards, the framework may ensure that e-learning tool is valid, reliable

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and useful in enhancing students' understanding of the cell division topic. This framework will also guide the design of the research methodology, including the processes for validation, pilot testing and field testing of the e-learning tool.

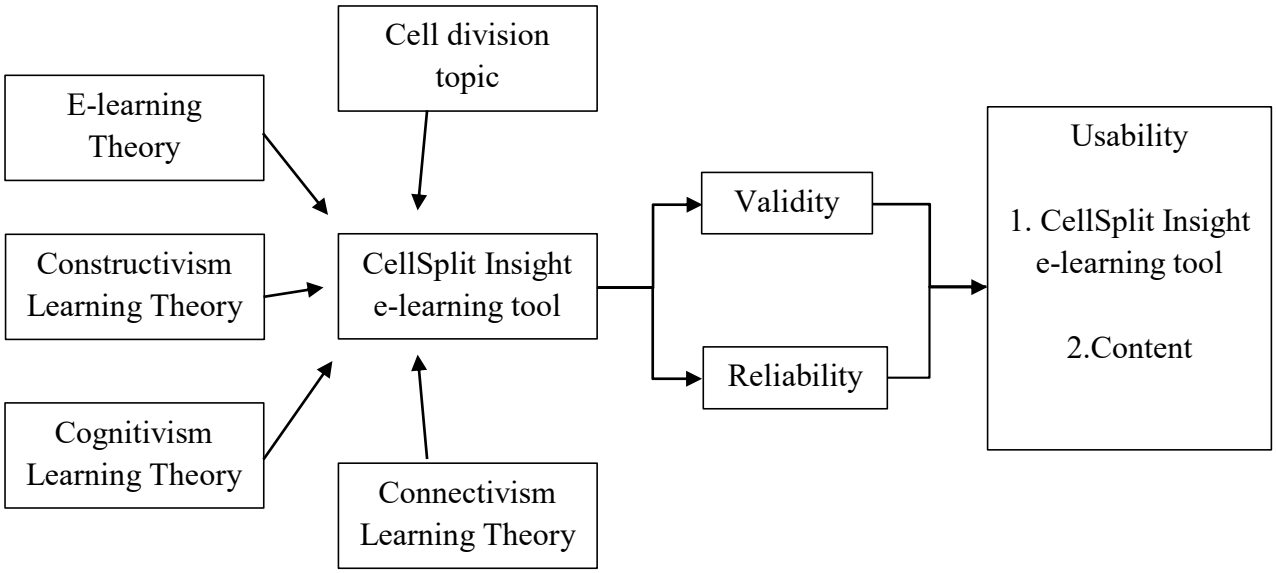

Figure 1.2. The conceptual framework of the project.

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1.9 Operational Definition

The operational definition of terms provides a detailed explanation of the technical terms and measurements used during data collection to standardise the process. Clearly defining how data should be collected is essential, as undefined data can lead to inconsistencies and may not yield the same results in a replicated study. It is easy to assume that those collecting the data know exactly what to do, but varying interpretations can impact the accuracy of data collection. Thus, to ensure consistency, a precise operational definition of terms is necessary. In this research, the operational

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definition of four terms will be discussed further in this section. The terms include development, usability, e-learning and cell division.

1.9.1 Development

According to Ulrich and Eppinger (2016) and Ullman (2010), development is the process of designing new and unique items that provide the consumer with new or improved benefits which might include creating a whole new product that meet a recently identified market niche or altering an existing product, including how it is presented. In this final year project, development means to take action to create or develop an e-learning tools focused on the topic of cell division which is usable to students helping them to improve their understanding of the concept of cell division.

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1.9.2 Usability

Nielsen (2016) stated that usability is about learnability, efficiency, memorability, errors, and satisfaction. In this final year project, usability refers to the usefulness, ease of learning, ease of use and satisfaction of the e-learning tool to help students in learning the topic of cell division.

1.9.3 E-learning

Raidah Yazid, Nur Syazwani Sukormo, Faaizah Shahbodin, and Siti Nurul Mahfuzah Mohamad (2021), stated in their study that e-learning is a term used in education to describe web 2.0 technologies and applications into educational and institutional

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activity. In the project context, e-learning refers to the development of digital-based learning tool that designed to help students to improve their understanding of the topics of cell division.

1.9.4 Cell division

Ong and Torres (2019) stated in their study that cell division, also known as mitosis, is the process that a mother cell divides its nuclear and cytoplasmic components into two daughter cells. In the context of the final year project, cell division refers to the Chapter 6 in Form 4 Biology syllabus which contains the subtopic of cell division, cell cycle and mitosis, meiosis and issues of cell division and human health. The cell division chapter will be focused in the e-learning tool.

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1.10 Summary

In short, this chapter provides an overview of the introduction of the research project. It begins with the discussion of the research background in detail. The issues and problems that are encountered by most of the Form 4 biology students when they are studying the subject of Biology where the topic of cell division including the process of mitosis and meiosis and the chromosome behaviour in both of the processes are also discussed in depth. The research objectives and research questions for this research project also had been introduced in the chapter. The significance of the research project is also elaborated in this chapter. After the discussion of the significance of the research, the limitation of the research in the context of the developed learning tool itself and the

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process of data collection also stated in the chapter. A close look to the conceptual framework of the research project also provided in the chapter before the operation definition which discussed the terms that used in the research project had been discussed in depth.

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