An Investigation of Student Experience of STEM Mobile Learning in a Local Malaysian University

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ABSTRACT
Students in Malaysia are reluctant to learn STEM, and it has a low uptake in Malaysia at the tertiary level. The advent of educational technology, such as mobile learning, gives hope that students will become more motivated to learn STEM. Hence, this research is conducted to investigate the student experience of mobile learning of STEM subjects through student-generated activities. In addition one of the student-generated activities approach in mobile learning is student generated content. The methodology used in this research is largely qualitative employing focus group discussions with students and interviews with lecturers from a local university in Malaysia. Thematic analysis was used to garner the emerging themes from the data. The results of the findings show an improvement, and that the student-generated activities approach did motivate university students in learning STEM subjects. Thus, the findings show the positive impact of mobile learning for STEM and insights into further implementing mobile learning in the learning of a wide variety of STEM subjects.

Author Keywords
Mobile devices, Student-generated Activities, STEM

INTRODUCTION
Student-generated activities is an approach in which students actively participate in their subject assignments unlike traditional teaching where students sit passively while listening to their lecturers in the university. This learning approach aims to enhance the student learning experience. It involves a deeper learning with a higher order level of thinking from student-generated activities (Ariffin, 2014; Dyson, 2012). Despite the worldwide emergence of mobile technology and digital content, there is a serious lack of local learning digital content including STEM subjects at the tertiary level in the Malaysian context; the available digital content relates more to the Western context than that of the local cultural context. Moreover, local content is important as students can relate their subjects to their own normal life (Ariffin, 2014; Ariffin, Yatim, & Ismail), and this scarcity of digital mobile content makes it difficult for students to learn and understand their subjects (Ariffin 2017a; Ariffin, Dyson & Hoskins-McKenzie, 2012). Likewise, Malaysian ministers have also urged the development of digital content, particularly for mobile phones, to facilitate the learning of local users (Bernama, 2010; Lim, 2005). Thus in this research context, one of the student-generated activities approach in mobile learning is student generated content (Ariffin, Sidek, & Mutalib, 2018).

MOBILE LEARNING
Gupta, Garg and Arora (2016) reported that there are about 6 billion mobile phone users worldwide. Although mobile learning in Asia is considered to be a fairly new approach to access education, it makes education more accessible in that it enables learners to pursue their learning according to their own schedule. The portability of mobile technology means that mobile learning is not bound by fixed class times, thereby enabling learning at all times and in all places, during breaks, before or after working shifts, at home, or on the go. Based on previous research, the results of six mobile learning projects that took place in several developing countries in Asia – the Philippines, Mongolia, Thailand, India, and Bangladesh – indicate that the developing nations in the Asian region could potentially be the leaders in the educational uses of mobile devices (Motlik, 2008).

Mobile learning facilitates the design of authentic learning, meaning learning that targets real-world problems and involves projects to suit the learner (Kukulska-Hulme & Traxler, 2007). This enables learning that occurs across time and place as learners apply what they learn in one environment to different contexts of development (Sharples, Taylor & Vavoula, 2010). Additionally, theoretically, mobile devices, such as mobile phones, make learner-centred learning possible by enabling students to customise the transfer of and access to information in order to build on their skills and knowledge, and to meet their own educational goals. Students are more empowered through mobile learning.
approaches. The phenomenon of using mobile devices gives effect to learning and teaching is related to mobile learning. For example, day-by-day, countries, such as Malaysia, are increasingly utilising mobile learning in education. In fact, many institutions of higher learning are using mobile learning in an increasingly wide variety of applications. The transformation in the involvement of users includes from exclusively higher income to lower income usage for mobile learning activities (Embí & Nordin, 2013). Additionally, Nordin, Embí, Norman and Panah (2017) highlighted the evolution of mobile learning history in Malaysia from early 2000 to 2017, from the basic functionalities of mobile learning to more advanced utilisation. Their research indicates the trends and varieties in mobile learning, particularly about learning anytime and anywhere, and particularly in Malaysia.

STUDENT-GENERATED ACTIVITIES
The emphasis of student-generated activities focuses on students actively using mobile devices in creating learning content for their subjects (Dyson, 2012). Likewise, there are opportunities for student content-generated activities, which have been demonstrated in learning the local culture in the Malaysian context (Ariffin, 2014). In addition, this strategy has been explored in STEM for mobile learning in Western countries (Traxler & Crompton, 2016), and, potentially, can be extended to student-generated activities for STEM in the Malaysian context. Ariffin (2014) recommended that student-generated content be explored for STEM subjects.

According to Terkowsky, Haertel, Bielski, and May (2016), using mobile device technology encourages STEM education in that learners learn actively and creatively and attain an improved understanding of the subjects. Furthermore, the development of the local Malaysian content for STEM is parallel to the Malaysian Education Philosophy of “emphasizing the strengthening of the quality of STEM education to develop the human capital that is knowledge, skilled, virtuous, creative and competitive”. The Malaysian Development Education Plan 2013-2025 placed STEM as one of the important agenda items for the transformation of the young generation for the 21st century. This shows how important STEM is in education to transform the education into a better future. In Malaysia, the student ownership of mobile phones is 100 percent, and they are very knowledgeable and tech-savvy in utilising mobile phones. This indicates that students in Malaysia are becoming more advanced in utilising the functions of mobile devices for learning activities (Hussin et al., 2012). Consequently, using mobile devices for learning purposes can enhance students’ learning in many subjects (Ariffin, 2014).

There are limited studies on STEM for mobile learning student-generated activities in Malaysia. Nithia et al. (2015) stressed that STEM in Malaysia for mobile learning has yet to be explored. There is potential to explore STEM associated subjects in Malaysia with the use of mobile learning for student-generated content (Ariffin, 2014). The Malaysia Education Blueprint 2013-2015 (2015) stated that the factors concerning the declining enrolment and quality of student outcomes in STEM are because of the limited awareness about STEM, as the subjects are difficult to learn. This includes the difficulty in understanding STEM, as well as the content-heavy curriculum, inconsistent quality of teaching and learning, and limited and outdated infrastructure. To overcome these issues many steps have been taken, including integrating face-to-face ICT instruction, deploying new instructional strategies and pedagogical approaches, and utilising adaptive learning software to learn at their own pace, and through their preferred learning style. In addition, STEM can potentially stimulate students’ interest through new learning system approaches and enhanced curriculum by means of mobile devices. The issue here is the lack of awareness concerning the exploration of mobile learning and knowledge of the latest technology among students in terms of learning subjects including STEM. Thus, mobile learning for student-generated activities for learning content (Ariffin, 2018, Ariffin, 2017a; Ariffin, 2017b; Ariffin, 2016a; Ariffin 2016b; Ariffin 2014) could be one of the possible solutions to attract students in learning STEM by making learning engaging and motivating.

METHODOLOGY
This research is largely qualitative and emphasises a deeper understanding of the data (Silverman, 2013). This study assumes that students already own mobile devices and have created some content using them (Ariffin, 2014). The study involves focus group discussions and interviews for a local university in Malaysia.

In addition this study is supported by a descriptive survey.

FOCUS GROUP DISCUSSIONS
The Student Participants: The local Malaysian student participants in the five focus groups numbered 30 in total. The students’ ages ranged from the early twenties to twenty-five years old. Focus group discussions were selected as an appropriate method for data collection from the students, as Malaysian students are more responsive when they discuss as members of a group than when they are asked questions individually (Ariffin, 2014). The focus group discussions were conducted with students involved in the STEM subjects. These subjects were Discrete Mathematics,
Computer Organisation, Biology, and Robotics and Design. Table 1 illustrates further the focus groups organised according to subject.

Table 1. Students Focus Group

<table>
<thead>
<tr>
<th>Course</th>
<th>Lecturer Code</th>
<th>Focus Group Code</th>
<th>Subject</th>
<th>Course code</th>
<th>Participants No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineering</td>
<td>L1</td>
<td>FG1</td>
<td>Discrete Mathematics (FT1)</td>
<td>AC10</td>
<td>5</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>L2</td>
<td>FG2</td>
<td>Computer Organisation (FT2)</td>
<td>AC10</td>
<td>5</td>
</tr>
<tr>
<td>Chemistry</td>
<td>L3</td>
<td>FG3</td>
<td>Biology (FT3)</td>
<td>AT11</td>
<td>7</td>
</tr>
<tr>
<td>Robotics</td>
<td>L4</td>
<td>FG4</td>
<td>Robotics (FT4)</td>
<td>AT47</td>
<td>6</td>
</tr>
<tr>
<td>Computer Design</td>
<td>L5</td>
<td>FG5</td>
<td>Design (FT5)</td>
<td>AT47</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td></td>
<td></td>
<td><strong>30</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: ‘FG’ = Focus Group, for example, FG1 = Focus Group 1, ‘L’ = Lecturer, for example L1 = Lecturer 1

Figure 1. Focus Group Discussion

FOCUS GROUP PROCEDURE
The discussions were based on semi-structured, open-ended questions, with additional questions added as each discussion progressed, thereby adapting to the students and their experience and their responses for mobile learning (Ariffin, 2014) in STEM. The duration of most of the focus group discussions was from approximately thirty minutes to one hour. Among the semi-structured questions asked were:

- What was the learning background of the students?
- What was the experience of the students in terms of student-generated activities for learning STEM?
- What were the challenges from the student-generated activities for learning STEM?
- How did the students overcome the challenges in terms of the student-generated activities for learning STEM subjects?
- What were the benefits from the student-generated activities for learning STEM?

INTERVIEWS
Semi-structured interviews were conducted with the class lecturers. This was to triangulate the findings with the lecturers about the students’ experience of doing student-generated content activities (Ariffin, 2014). The lecturers were asked semi-structured questions similar to those that the STEM students were asked concerning their experience in terms of the student-generated activities.

THEMATIC ANALYSIS
Thematic analysis was the methodology used by the researcher for examining the data from the interviews and focus group discussions. The themes were derived after subjecting the data to the thematic analysis process. Braun and Clarke (2006) stated that the study of thematic analysis involves familiarising oneself with the transcripts, initialising the code, and making sense of the data to emerge as themes. Additionally, in this research, the answers of the participants were audio recorded. The audio was then transcribed into the Malay language (Bahasa Melayu or Bahasa
Malaysia). Occasionally, the researcher had to listen to the recordings several times to obtain an accurate transcription. Subsequently, the Malay language transcription was translated into English. Generating themes required processes such as coding, combining the coding into groups of themes, and themes being reorganised if required (Saldaña, 2009). Similarly, Auerbach and Silverstein (2003) pointed out that the coding stage is a non-linear process and can loop backwards, with alterations to the coding and themes as the development of the themes progresses. The themes were organised again to guarantee the understanding of the data and that the analysis was coherent with the thematical context (Braun & Clarke 2006).

SURVEY
Additionally for this research, the participants are degree students from five (5) different courses. A total of 112 students aged 19-25 from five (5) classes – two classes from the same course – responded the questionnaire. Their response were based on their experience and understanding in using mobile learning student generated activities for STEM. Likewise the Likert scale was utilized for the descriptive statistics for the mean from lowest to highest from 1 to 5. The expectations are publicised such as in Table 2.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Value (Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>Rarely</td>
<td>2</td>
</tr>
<tr>
<td>Sometimes</td>
<td>3</td>
</tr>
<tr>
<td>Regularly</td>
<td>4</td>
</tr>
<tr>
<td>Always</td>
<td>5</td>
</tr>
</tbody>
</table>

The mean formula for this research is shown in Figure 2, which is derived from the average formula (Ariffin, Sidek, & Mutalib, 2018).

\[ \mu = \frac{P \times Y}{N} \]

\[ \mu = \text{Mean/Average} \]
\[ Y = \text{Scale Value} \]
\[ N = \text{Total number of students (112)} \]
\[ P = \text{Question} \]
\[ X = \text{Issue} \]

Figure 2. The formula for the Mean

FINDINGS
The interviews and focus groups that followed the student-generated local content activities demonstrated the involvement of the participants with this type of learning, such as classroom activities and fieldwork activities. The students reported that they are engaged in self-exploratory learning using mobile devices. In addition, they worked collaboratively with friends in doing their assignments. These activities involved a mixed use of mobile devices, such as mobile phones, cameras, and laptops. In these activities, mobile learning was utilised as a complement to enrich existing learning. The activities revealed that mobile learning contributes to achieving the student-generated activities, particularly in the creation of multimedia content for STEM in a local university. Figure 3 and Figure 4 shows some examples from the student generated activities in accomplishing their assignments using mobile devices.
Mobile phones with multiple functions to generate content, such as video, audio, and photography, were used by the participants. For example, the students reported using mobile devices, such as mobile phones in a self-exploratory learning approach for doing their assignments. Hence, this section shows the students’ benefits in accomplishing assignments in terms of the student-generated activities by using mobile devices in generating multimedia content for STEM.

**Video:** Video was one of the most utilised functions that assisted students to produce video content for their assignments using their own mobile devices. Some examples:

“Students have to take the video and explain the movements of the individual robots.” L4

“My students used mobile phones or mobile devices to record the science experiment.” L3

“The multimedia content that I produced is a video of what we did in the group work as part of our final lab project.” FG2

**Photos:** The participants reported that their students used mobile phone cameras to take photos to accomplish their assignments. An example:

“We used multimedia content, such as video, banner or photo editing, and so on.” FG5

**Audio:** The participants indicated that they used the audio function on their mobile devices to generate digital audio content. An example:

“For audio, we used Audacity to record voices.” FG5

**PowerPoint:** Academic L4 mentioned that his students created PowerPoint slides. FG1 and FG4 also informed that they developed PowerPoint slides for their assignments. Some examples:

“Students are also required to compile all the documents in terms of coding, video, PowerPoint slides in a video or DVD of the DVD, and the content should be sent to me, and I check it myself.” L4

“During the presentation, the lecturer told us to present a topic, so we used a slide show, which we presented at the front.” FG5

**Programming Application:** Academic L4, focus groups FG4 and FG5 mentioned the programming content that the students need to develop for the subject assignments:

“With the use of the technology available at the present time, students no longer need to memorise the codes. For the time being, the students only need to understand the graphic user interface GUI code and reuse it for specific usage where they can see their first output.” L4
“The mobile device that I used is a laptop because this mechatronic uses technology. We used the Arduino app on the laptop to create the robot.” FG4

DEVELOPMENT OF NEW MULTIMEDIA SKILLS

Mobile learning has contributed in developing new skills for the students, such as being able to record and create their own videos using mobile devices. Some students reported that they were able to generate their own local content using mobile devices. Additionally, this digital content was transferred to laptops for further editing using software, such as ‘Viva Video’, to produce digital video content. Thus, these findings demonstrate that the participants gained video creation skills. These skills will continuously assist the students in using mobile devices to help in their future tasks as well as in other subjects.

Video: Academics L2, L3, L4 and L5 highlighted that the students made use of their skills to produce videos. Most of the student participants gained video skills using mobile devices for the student-generated content activities. Some examples:

“I just encouraged them to use software, such as Viva Video, which is software that can be used to record a video and for simple editing, so far so good.” L2

“Using a mobile device, we recorded a video with the phone and edited the content after the work was completed.” FG2

Power Points: Participants, such as L1, L4, FG4, and FG5, also informed that the students made use of their PowerPoint skills. They used PowerPoint for their assignment presentations:

“PowerPoint I think is useful to explain stem science, engineering, and mathematics subjects as we use presentation slideshow that relates to multimedia.” FG4

Audio: FG1 and FG5 stated that they made use of audio editing skills:

“For audio, we used software such as Audacity to record voices and for editing.” FG5

Photo: Participants, such as FG5, also made use of their photo editing skills:

“We already know how to use Snappy, so we just applied Snappy when it involved images.” FG5

ACHIEVING BETTER LEARNING OUTCOMES

The participants reported better learning and understanding from the student-generated activities for STEM. They were motivated and had worked collaboratively. This approach leads to a better quality of assignments compared to a traditional approach. Additionally, their teachers praised the students’ collaborative efforts in using mobile devices to generate local digital content for assignments. As a result, the students had a better understanding of the subject because of their participation in student-generated activities. Additionally, the students also gained life learning skills that could be applied to other subjects and their working life after they graduate. Therefore, these findings demonstrate that the subjects had improved their learning outcomes by embedding the STEM student-generated activities.

Good Quality of Assignments: The academics reported that the participants generated better quality assignments using the student-generated content approach, compared to the previous approach in STEM subjects. Academics, L2, L3, L4, and L5, and focus groups FG1, FG2, FG3, FG4, and FG5 mentioned the STEM subject assignments from the perspective of student-generated activities. Likewise, the quality of the videos demonstrated by the participants showed that the students had understood the STEM topics they had been taught in class. Some examples:

“I take the computer organisation subject where I made a project video for installation of the hardware, and, to me, it was really fun because we can see the result after that.” FG1

Lifelong Learning Skills Experience: Participants L1, L3, L4, L5, FG1, FG2, FG3, FG4, and FG5 reported that they had gained lifelong skills, such as self-confidence, communication skills, and organisational and management skills, as a result of the STEM student-generated content activities. Thus, this demonstrates the impact of STEM student-generated activities in lifelong learning for the students and how they can use and apply the multimedia skills they gained to other subjects and after they graduate. Some examples:

“In this STEM programme, we had to do an activity with school kids through which I increased my confidence in speaking.” FG4
“I’m more confident in making multimedia content. When we have experience and knowledge about this programme we face it, so, based on that experience, I can apply it to my daily life.” FG4

“It’s about real-world application. I think it’s very closely related to STEM.” L1

**Improve understanding:** The students were reported to be working collaboratively and achieved a better understanding of the STEM subjects by doing their assignment and exploring by themselves using mobile devices in student-generated activities. Thus, these findings demonstrate that the students improved their understanding of the STEM subjects by participating in student-generated activities. Some examples:

“The manufacturing material must involve ceramic, composite, or steel. They seek to understand the product making technique.” L5

“For me, this STEM is better, because it can help the students to understand about the engineering system that relates to mathematics or science.” FG4

**LEARNING BY EXPERIENCE**
Participants, such as FG1, FG2, FG3, FG4, and FG5 students, reported a better learning experience which assisted them in learning the STEM subjects. This happened because the process of learning was more geared to empowering the students and to initiate their own learning.

**Using Actively:** The participants reported that they were motivated in doing their STEM assignments through actively experiencing the use of mobile devices. Some examples:

“Students are excited to use the mobile devices for assignments.” L2

“This activity of multimedia content is very motivating for me, for example, in discrete mathematics.” FG1

“Exciting, also because this is my first experience of making a CPU casing tower.” FG2

**Plan:** The participants reported that the STEM assignment activities had been planned by the students. An example:

“For me to plan the scheduled activities I just planned it by myself, and for the group, we used the phone and emailed what we discussed in the class, and, afterwards, we discussed using WhatsApp to update and to share content via email. If we get an email that is not right, then we can edit it and discuss through WhatsApp, and resend through email.” FG4

**Present:** The participants reported on how they presented their STEM work orally. An example:

“For presentation, basically I asked them to make a presentation video to be uploaded and send to the platform.” L2

**Reflect:** The participants reported on how they reflect on their STEM assignments. Some examples:

“They get the chance to review the records that have been done, and, next, can do reflective thinking by themselves to fix any flaws in the assignment.” L3

“Group brainstorming sessions are important because we get the idea from them and how we accept that idea, we discuss the advantages and the weaknesses.” FG5

**Apply:** The participants reported that they could apply the acquired skills and techniques to other subjects or similar activities. Some examples:

“This activity can be applied to other tasks as we know the technique and have the skills to produce a video, such as video making, and we know how to make videos. It will become even easier in the future.” FG2

“We can apply this knowledge of the work skills when we have to find jobs, for example, such as in accounting, mathematics, or engineering.” FG4

“Other than that, in robotics we used coding that is very basic, which is C++. From there the coding can assist us in the future for designing, producing, and execution from the application to enable the robot to move.” FG5

**STATISTICAL DATA ANALYSIS**
The findings from the survey is summarised from the descriptive statistical data analysis gained from the university students (Ariffin, Sidek, & Mutalib, 2018). On the other hand, the statistical data analysis is to support the largely
qualitative approach of this research. As illustrated by Figure 5, a total of 112 students answered the survey – males 41 (37%) and females 71 (63%). This shows that more female students than male students answered.

![Figure 5. Percentage of gender](image)

The statistics in Table 3 display the mean for mobile phone use for completing assignments: For record audio the mean is 3.53, record video has a mean of 3.58, take photo has a mean of 4.14, edit video has mean of 3.17, edit audio has a mean of 2.92, and edit photo has a mean of 3.45.

<table>
<thead>
<tr>
<th>Multimedia Utilization for completing assignments</th>
<th>None (1)</th>
<th>A Bit (2)</th>
<th>Moderate (3)</th>
<th>Good (4)</th>
<th>Excellent (5)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record Audio</td>
<td>10</td>
<td>12</td>
<td>30</td>
<td>29</td>
<td>31</td>
<td>3.53</td>
</tr>
<tr>
<td>Record Video</td>
<td>9</td>
<td>14</td>
<td>24</td>
<td>33</td>
<td>32</td>
<td>3.58</td>
</tr>
<tr>
<td>Take Photo</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>30</td>
<td>57</td>
<td>4.14</td>
</tr>
<tr>
<td>Edit Video</td>
<td>16</td>
<td>14</td>
<td>34</td>
<td>31</td>
<td>17</td>
<td>3.17</td>
</tr>
<tr>
<td>Edit Audio</td>
<td>19</td>
<td>21</td>
<td>36</td>
<td>22</td>
<td>14</td>
<td>2.92</td>
</tr>
<tr>
<td>Edit Photo</td>
<td>12</td>
<td>12</td>
<td>28</td>
<td>34</td>
<td>26</td>
<td>3.45</td>
</tr>
</tbody>
</table>

The statistics in Table 4 demonstrates the mean learning from experience for the student usage of mobile devices, such as mobile phones, in developing the multimedia content to help in doing assignments: Using for building concrete experience to do assignments has a mean of 3.6, using for reflection to plan to do assignments has a mean of 3.69, using for analysing and conceptualizing to do assignments has a mean of 3.81, and, lastly, to develop the confidence to apply to do assignments has a mean of 3.79. This indicates high means for learning by experience from student-generated activities.

<table>
<thead>
<tr>
<th>Learning from experience in developing the multimedia content</th>
<th>None (1)</th>
<th>A Bit (2)</th>
<th>Average (3)</th>
<th>Good (4)</th>
<th>Excellent (5)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building concrete experience to do assignments</td>
<td>0</td>
<td>9</td>
<td>33</td>
<td>55</td>
<td>15</td>
<td>3.68</td>
</tr>
<tr>
<td>Reflection to plan to do assignments</td>
<td>1</td>
<td>6</td>
<td>28</td>
<td>59</td>
<td>18</td>
<td>3.69</td>
</tr>
<tr>
<td>Analyse and conceptualize to do assignments</td>
<td>0</td>
<td>6</td>
<td>24</td>
<td>67</td>
<td>15</td>
<td>3.81</td>
</tr>
<tr>
<td>Develop confidence to apply to do other assignments</td>
<td>0</td>
<td>6</td>
<td>25</td>
<td>68</td>
<td>13</td>
<td>3.79</td>
</tr>
</tbody>
</table>

The statistics in Table 5 display the mean for students’ challenges when creating the multimedia content assignment: For wireless, the mean achieved is 3.96, phone hanged has a mean of 2.69, small mobile phone screen
3.05, editing and producing video has a mean of 3.30, and battery power has a mean of 3.38. Thus the wireless issue is the biggest challenge for student-generated activities in learning STEM.

Table 5. Challenges during the multimedia content development for the assignment

<table>
<thead>
<tr>
<th>Challenges</th>
<th>None (1)</th>
<th>A Little (2)</th>
<th>Moderate (3)</th>
<th>Good (4)</th>
<th>Excellent (5)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless</td>
<td>7</td>
<td>14</td>
<td>35</td>
<td>37</td>
<td>31</td>
<td>3.96</td>
</tr>
<tr>
<td>Phone Hanged</td>
<td>9</td>
<td>23</td>
<td>24</td>
<td>31</td>
<td>10</td>
<td>2.69</td>
</tr>
<tr>
<td>Small Screen</td>
<td>14</td>
<td>21</td>
<td>35</td>
<td>29</td>
<td>13</td>
<td>3.05</td>
</tr>
<tr>
<td>Edit &amp; Produce Video</td>
<td>8</td>
<td>18</td>
<td>32</td>
<td>40</td>
<td>14</td>
<td>3.30</td>
</tr>
<tr>
<td>Battery Power</td>
<td>6</td>
<td>21</td>
<td>26</td>
<td>43</td>
<td>16</td>
<td>3.38</td>
</tr>
</tbody>
</table>

EXAMPLES OF STUDENT GENERATED ACTIVITIES

Subject Computer Architecture and Organisation (PC Assembling)

Students have been assigned to develop multimedia content for assembling a PC. Following were the steps of snapshots recorded using mobile devices for student generated activities.

Step 1: Input the hard drive into its place.

Step 2: Put the fan to assemble.

Step 3: Allocate the RAM beside memory slot.
Step 4: Place the USB port

Step 5: Put the 50-pin socket

Step 6: Connect the 40-pin socket to the power supply

Step 7: Attach the wires to its connector

Step 8: Connect the LED wires into its connector
DISCUSSION

STUDENT EMPOWERMENT
The student-generated activities’ process for STEM in the Malaysian context, is inspired by the pedagogical approach of experiential learning (Dewey, 1938; Kolb, 1984; Naismith et al., 2004) as adapted for mobile learning from Ariffin (2014) and Dyson et al. (2008). The adapted experiential learning process for student-generated activities for STEM is applied to the Malaysian university context (Ariffin, 2018).

This study demonstrates how student-generated mobile learning activities positively benefit STEM subjects in the creation of local multimedia content. In addition, the students were empowered to complete their assignments using mobile devices through student-generated activities. These student-generated mobile learning activities are aligned with the studies demonstrating ‘learning by doing’ (Kolb, 1984). For example, this study has achieved a number of accomplishments: students doing and completing their assignments using mobile devices, the development of new multimedia skills in the creation of video and achieving better learning outcomes for the STEM subject.

This study is comparable with those of Ariffin (2014) and Dyson et al. (2008), which incorporated m-fieldwork activities that were learner-centred (student-centred). For example, the Dyson et al. (2008) study on m-fieldwork involved the subject ‘Introduction to Information Systems’ in 2007 in Australian universities. However, this research added the Malaysian university context in STEM for student-generated activities. Students created their own video multimedia content for STEM. This study demonstrates that students are more empowered, motivated, and engaged, and actively involved with student-generated activities through the creation of multimedia content (Litchfield et al., 2010). In addition, this approach is applied to their accomplishment in managing and completing their work for STEM (Ariffin, Sidek, & Mutalib, 2018).

Overcoming Challenges: Students reported that they managed to overcome challenges by collaborating with their friends, particularly in solving technical difficulties during STEM student-generated activities. These activities enhanced their learning and also assisted in generating multimedia content smoothly in the learning process. Student collaboration and peer assistance enhanced their use of a blend of mobile devices to support their learning activities in the creation of multimedia content (Litchfield et al., 2010). In addition, this study affirmed that by using the students own mobile devices benefited them in the creation of the multimedia content for STEM assignments. The student participants in this research did not need to be connected via wireless to access the Internet all the time since the capturing and editing of multimedia content could be accomplished in an offline mode. Likewise, they could do the transfer of files during non-peak hours, such as very early in the morning. Therefore, this study demonstrates the benefits of student-generated activities in solving challenges by various practices in this research.

Outcomes: The student-generated activity outcomes for experiential learning and the deeper level of learning in this research are illustrated in Table 6 and can be explained as follows:
### Table 6. Examples of outcomes for mobile learning student-generated activities for STEM

<table>
<thead>
<tr>
<th>Process</th>
<th>Comment</th>
<th>Example</th>
<th>Depth of Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Experience</td>
<td>Students became more explorative and adventurous collaborating amongst themselves in generating content with their own mobile devices in STEM classes</td>
<td>“Students have to take the video and explain the movements of the individual Robots.”</td>
<td>Shallow</td>
</tr>
<tr>
<td>Reflection</td>
<td>The participants reported consolidating their multimedia content with reports or presentations, such as embedding photos, video or audio. In addition, students gained multimedia skills in the creation of videos by self-exploratory learning and engaging in using mobile devices and collaborating with friends in their group in completing their STEM work.</td>
<td>“Group brainstorming sessions are important because we get the idea from them and how we accept that idea, we discuss the advantages the weaknesses.”</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Students reported a better understanding and knowledge of their STEM subjects from the concept or theory through student-generated activities in using mobile devices. The student participants achieved better learning outcomes, as demonstrated by the high quality of multimedia content.</td>
<td>“For me, this STEM is better because it can help the students understand about the engineering system that relates to mathematical or science theory.”</td>
<td></td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>The students can apply the skills they gained in STEM with student-generated activities; for example, in creating a video when they study other topics in similar or different subjects.</td>
<td>“We can apply this knowledge of the work skills when we have to find jobs, for example, such as in accounting, mathematics, or engineering.”</td>
<td>Deep</td>
</tr>
</tbody>
</table>

**INCREASED AWARENESS**

This study demonstrates an increased awareness for accessing and sharing content. In this study, the researcher advised the participants to instigate using mobile devices for assignments in STEM, and, subsequently, a number of classes have also implemented using mobile devices. The participants reported being more aware of the mobile phone functions beyond SMS and phone calls. Moreover, this study also demonstrates some examples of students at a Malaysian university sharing content (Ariffin, 2014; Ariffin, Yatim, & Ismail, 2018) in learning STEM. Students also made use of the video recording for learning purposes (Ariffin, 2014), such as in computer organisation. Thus, there is an increase in sharing educational resources for better accessibility among academics and students in the study of STEM, using mobile devices (Ariffin, 2018; Ariffin, Sidek, & Mutalib, 2018).

**MORE INTEREST IN MOBILE LEARNING AFTER STUDENT-GENERATED ACTIVITIES**

Academics reported being more open, particularly after being exposed to student-generated content activities after witnessing the good performance of their students in creating quality multimedia content. They encouraged their students to use the multimedia functions of the mobile phones, such as the video recording, audio recording, and photography functions. This experience is aligned with the studies of Pouzevara and Khan (2007), and Valk, Rashid and Elder (2009) in Bangladesh, and mobile learning local culture (Ariffin, 2014), which reported that teachers were more appreciative of the use of mobile phones after student-generated activities. They changed their attitude and had more interest in using mobile phones for learning after experiencing the mobile learning activities. Thus, academics are more open now compared to previously in using mobile phones for classroom and fieldwork activities.
CONCLUSION
Notwithstanding of the emergence of mobile learning is widely embraced by developed countries, the research for STEM in mobile learning student-generated activities is fairly new in the Malaysia context. This means there are more opportunities for investigations for mobile learning student generated-activities in Malaysia. Meanwhile, the impact of this study is the holistic understanding of the participants’ perspectives and experiences from the student-generated mobile learning content activities, as one of the ways to remedy the lack of local content for STEM in the Malaysian university. In addition, the impact of mobile learning was demonstrated through the academic and student themes developed for STEM student-generated activities. Mobile learning student-generated content could also be applied to other subject areas and could empower students in developing local content for learning STEM. Likewise, more sophisticated uses of mobile devices indicate a greater awareness of the utilisation of mobile devices for student-generated STEM activities in Malaysian universities. For instance, this study demonstrates that students are capable of producing multimedia content with minimal supervision from their academics, and promoting a better quality of learning content and understanding of the subjects for STEM in the Malaysian university context. Importantly these capabilities reduce the challenge of a lack of local content in Malaysia. This study illuminates further possibilities, such as students becoming content producers in future assignments with similar activities in STEM for larger participation. Students at Malaysian universities could use the multimedia skills they gained in STEM for other subjects or when they graduate to teach their own school students. Thus, embedding the mobile learning student-generated activities in STEM subjects could encourage the development of mobile learning student-generated content while reducing the lack of local content challenge for Malaysian universities. Since this research is at the early stage, the current and future works including exploring different users’ perspectives and experience and of mobile learning student-generated content in STEM subjects in the existing and other universities.

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