The development of device learning based on TPACK (technological pedagogical content knowledge) in the form of hypercontent modules in electronics courses

S Rufaida*, Nurfadilah
Program Studi Pendidikan Fisika, Universitas Muhammadiyah Makassar, Sultan Alauddin No. 259, Makassar 90222, Indonesia
*salwa@unismuh.ac.id

Abstract. This study aims to develop a device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses that combine technological, pedagogical, and material content knowledge by using QR code as a learning navigation tool so it acts as open resources for learning. This device sustains the 21st century system and independent learning, because students can begin to learn the subject needed with non-linearly and facilitate learning styles by providing variety of learning resources such as site addresses, journal texts, videos, audio, and images that can be accessed with QR code reader so learning feels contextual and able to direct students to think creatively in learning. Research and development carried out using the Borg and Gall models with the step of collecting information, do the planning, developing product formations, testing, revising, disseminating, and implementing the product. This research shows that device learning based on TPACK in the form of hypercontent modules is valid, practice, and effective for use in electronics courses as seen from the improvement of student learning outcomes.

1. Introduction
Facing the 21st century learning era, where students are required to be able to develop and integrate cognitive abilities with their skills also become an important concern for lecturers as educators. In this case, the integration between mastery of subject matter with critical thinking skills, communication, collaboration, and creativity is expected to help students achieve success in their future careers. The skills are expected to affect his ability to use his understanding to solve real world problems. These demands certainly have implications for learning patterns in the classroom that have been directed towards 21st century learning and pay attention to future needs, including developing a learning technology that is expected to make the learning process more effective and efficient. One of learning technologies developed today is TPACK learning (Technological Pedagogical Content Knowledge). TPACK learning focuses on collaboration between technological, pedagogical, and material content knowledge to achieve learning goals.

According to research conducted by Nielsen Consumer & Media View in 2016 that students who are Z generation mostly use television, internet, and radio as the main media to get information [1]. As a generation born in the digital era, internet access is an important requirement for students today. Internet cafes have been replaced by homes because around 97% of teenagers can access the internet at home through mobile devices such as smartphones or iPhones. It can be an opportunity for educators to
take advantage of this moment to develop a learning technology based on the tendency of current student needs for mobile devices. This is the goals of TPACK learning development which is utilizing technology in the form of applications on mobile devices as an effort to improve educators’ pedagogical knowledge when delivering material content so that learning goals can be achieved optimally.

TPACK learning can be integrated with a models or methods which can train students to find new knowledge independently but still gets teacher guidance. This shows that TPACK learning is a student center learning which directs students to find and construct their knowledge independently so as to obtain new knowledge [2]. Professional educator should be have TPACK competencies which include the four main competencies of educators such as pedagogical, professional, personality, and social according to global education trends in the framework of 21st century learning and integration of skills in learning such as communication, collaboration, creativity, and critical thinking [3]. TPACK learning is packaged in a hypercontent module that contains QR code as a navigation tool that can direct students to access material content available in the QR code that may contain site addresses, journal text, video, audio, or other learning resources. Hypercontent modules have the characteristics that each unit in the module is designed to independent so it is categorized as a self-contained learning and students can learn randomly or start and end any unit [4].

Furthermore, the structure of material content is packed with message design principles which can contain literature, tests, and enriched with material from cyberspace with hyperlinks to go to a specific link with QR code as a tool. QR code has a larger data capacity for storing data in the form of URL password that are linked to certain web page that contains information, if scanned with QR code reader the link will be displayed on the screen of the mobile device and the user can decide whether to open it or not in the browser application [5]. QR code integration in learning is one of the technological developments which direct students to easily interpret learning materials in a short time through visualization. Learning methods can be more effective with visual media. QR code facilitates learning by providing a reality of objects in the form of images, audio, text, and animation or video learning in detail, so that it becomes practical and interesting [6]. Digital information combined with physical objects is the future trend of education in the form of QR code as a means of delivering information and knowledge [7].

Basically, students’ literacy skills in 21st century learning are needed. The appearance of TPACK learning can be an alternative to improve technological literacy because it is open sources for learning through technology. The existence of educational technology innovations will be change students paradigm from contemporary to computational using devices, so that making it easier for future work [8]. It needs to be emphasized that 21st century generation needs skills to access, evaluate, use, manage, and enrich information through various media available at this time. Technological literacy can strengthen digital generation capabilities to think, learn, communicate, collaborate, and create [9]. One of digital literacy that is commonly used by students is using internet as a learning resource. Therefore, TPACK learning will direct students to be able utilize technology in the digital era as an alternative learning which facilitates the implementation of learning by using tools in the form of QR code which contains material content that is so that it can help educators in practicing pedagogical skills, especially to convey learning.

Hypercontent module is also called hypertext will be more efficient and paperless. All the time, module or teaching materials is packed with many pages, so students feel bored or not interested to read it. If the module is packaged more minimalist and display a lot of content inside it, so the module feels as contextual learning that can be accessed anytime and anywhere through available mobile devices. Hypertext has many advantages of the stack of paper that contains information, because it is more accessible and consists a few pages that contains a lot of material content that can be obtained cheaply and quickly with internet assistance [10]. There are several benefits of using hypercontent modules such as module content that can be read by anyone who is interested in developing self-potential, module design can be applied to any subject that is based on cyberspace as an open resource for learning, QR code as an alternative to direct link readers see sources learning so as to avoid content that is not on target or mistyped the site, and material content viewing that train students to be self-
contained learning [4]. Collaboration between technological, pedagogical, and content knowledge will direct students to achieve the knowledge and skills needed in 21st century era.

2. Methods
This type of study is research and development, which aims to produce learning devices and test the validity, effectiveness, and practicality of the product in the field. Research and development is a process used to develop and validate educational products [11]. To be able to produce a product, research that is needs analysis is used and to test its effectiveness in the wider community, research is needed to test its effectiveness [12]. In this study, a device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses developed with Borg and Gall model, which begins with information gathering phase as needs assessment with observations and literature reviews stage, then plan product by developing product goals and designs. The product format is developed as an initial draft in the form of hypercontent module design that will be made then the first test was conducted with research subjects on a small scale as material for initial product revision. After making improvements to the initial product revision, it will be trialled again with research subjects on a medium scale and continued by revising the advanced product which is intended to measure the successful manufacturing of products and goals of making hypercontent module. The last test was carried out on a large scale to be revised as the level of product validation before finally being disseminated and implementation in the field. Based on these phases, the level of validity, practicality, and effectiveness of hypercontent module will be measured.

3. Result and Discussion

3.1. Needs Assessment
The research begins with gathering information as a description of the needs assessment in the field for the product to be developed. The needs assessment is carried out within the framework of the questions regarding such as what is the learning problems are faced in the electronics courses? Then, can the application of technology affect the achievement of better learning outcomes? And how is the form of learning desired by students in electronics courses?

According to observations, obtained information that students still feel comfortable with expecting lecturers as their main learning resources or lecturer centered learning. At the time given task or project, the student makes the Internet as a primary source of information, but is still not able to sort out the appropriate resources, so learning achievement students is still minimal. Electronics is one branch of physics that studies about weak current electrical devices that are operationalized by controlling the flow of charge in an electronic device. The content of the material in the course has never been obtained by students when they are at the middle and high school level, so students have difficulty in the process of reconstructing knowledge if they only read thick books because they tend to feel tiring and boring. According to interview result with several students that student motivation is influenced by the lack of ability of lecturers to make effective pedagogical practices (pedagogical knowledge) and mastery of material (content knowledge) by integrating a technology in the learning environment. Students are only focused on books and lab reports which are thick and not interesting to read. According to need assessment, then a literature review on the product to be developed.

3.2. Planning, Development, and Testing
At this phase, the product began to be designed to create a hypercontent module consisting of several modules of modules covering several chapters of material in the electronics course. The module is made as efficient as possible with some QR codes that serve as student navigation tools to access the unit of material they want to learn. The QR code contains material content in the form of video, audio, journal text, presentation material, quizzes or questions, as well as other interesting content such as the following image.
Figure 1. Display of the hypercontent module in electronics course

Figure 1 shows that one page of the hypercontent module displays in the electronics course. In one unit of material, there are several sub-units that are displayed through the QR code which contains the material content. Students can access the contents of the QR code by transferring or scanning using the QR code reader application available on the smartphone, so that students can obtain learning resources and information quickly and accurately related to the content of subject matter through technology. The QR code is able to store greater information and can be accessed through a device with a QR code reader. Students don’t have to remember or type long URL addresses to access information because it is facilitated by the QR code application which directly brings students to the information available and needed by students [4].

After the testing of hypercontent module on small and medium scale subjects and revision process, the module is tested on large subjects to be revised as a preparation for the dissemination and implementation phases.

3.3. Dissemination and Implementation

According to planning, development, testing, and revision results of hypercontent module, dissemination and implementation phases are carried out to measure the validity, practicality, and effectiveness of the product being developed. Validity can be seen during the repeated trials and revisions, practicality can be seen from limited trials of the large scale subjects through the response of educators and students, and effectiveness can be seen from student learning outcomes after the hypercontent module is implemented in the learning process. The data on student learning outcomes in electronics courses before and after the implementation of hypercontent module are shown in the following table.
Table 1. Observation table of student learning outcomes in electronics before and after the application of TPACK learning in the form of hypercontent modules

| School year | Average value | Frequency of students pass (%) |
|-------------|---------------|-------------------------------|
| 2017/2018   | 66.65         | 80.20                         |
| 2018/2019   | 68.60         | 82.35                         |
| 2019/2020   | 72.64         | 87.50                         |

Table 1 shows that in 2017/2018, students only achieved an average value of 66.65 and 20% of students did not pass the electronics course. In 2018/2019, the average value of students was of the better level in 68.60 and 18% of students did not pass the electronics course. Thus, in 2019/2020, lecturers take the initiative to implement a device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses as a form of innovative learning strategy with the hope that students would get better value through the reconstruction of knowledge based on their ability in technological literacy. Interesting learning is also expected to be a solution in increasing the number of students who pass in electronics courses. According to observations result, implementation of device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses can be seen that there is an increase in the average value in electronics courses to 72.64. Although the increase is not so significant, it is better than the average value of student achievement in the previous two academic years. That may be said one of the implications of the application of innovative learning models used by lecturers in electronics courses. TPACK learning is the basis of effective teaching with technology to teach material content so that it helps correct some learning problems and build student knowledge [3].

Beside from the test of students learning outcomes, interviews were also carried out to find out students satisfaction who were learn using hypercontent module. Most of them expressed a great interest in the hypercontent module because students could access the learning resources anytime and anywhere only by scanning the QR code available. Other than that, the features offered in the hypercontent module can facilitate a variety of student learning styles that are certainly different. In the hypercontent module a media presentation is prepared for students who have a visual type in learning, and video for audio visual students. Some features about experiments that make it easier for students who have a kinaesthetic learning style. Through the hypercontent module, students can access many learning resources so that students can understand the electronics content material although it hasn’t been studies before. The application of TPACK learning can minimize lecturer centered learning in the course because it is represented by a variety of interesting learning resources available in the hypercontent module, but lecturer remains a facilitator. TPACK learning is also leads to 21st century learning which gives knowledge about effective solution to selection an innovative learning strategies, because after studying used hypercontent module students must be able to sort out information obtained with critical and creative thinking and present their knowledge that can train scientific communication skills student.

4. Conclusion

According to research results the development of device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses, it can be concluded that TPACK learning is valid, practical, and effective to increase the student learning outcomes and skills needed by students in the 21st century framework. TPACK learning can also help lecturers to increase their competence and professionalism, especially the use of technology in the 21st century learning to achieve learning goals of electronics courses. Other than that, device learning based on TPACK (Technological Pedagogical Content Knowledge) in the form of hypercontent modules in electronics courses can maximize the ability of students to understand the material content, improve the quality of learning with technology, and make the presentation of courses more interesting, as an alternative linking the acquisition of knowledge through the provision of knowledge verbal theory with
practicum. It can be a provision for students who want to apply the same learning model and media through technology literacy after becoming a graduate.

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