The effectiveness of hypercontent module to improve creative thinking skills of prospective physics teachers

S Rufaida¹ and N Nurfadilah²

¹Graduate Program of Education, State University of Makassar, Jl. A P Pettarani, Makassar 90222, Indonesia
²Department of Physics Education, Muhammadiyah University of Makassar, Jl. Sultan Alauddin No. 259, Makassar 90222, Indonesia

*Corresponding author: salwa@unismuh.ac.id

Abstract. Hypercontent module as one of Technological Pedagogical Content Knowledge (TPACK) learning device contains collaboration between technology, pedagogy, and material content equipped with Quick Response Code (QR Code) as a learning navigation tool that is open source for learning, so it is expected to improve students' creative thinking skills in information processing as new knowledge through technological literacy. This study aims to analyze the effectiveness of the hypercontent module to improve creative thinking skills of prospective physics teachers. The hypercontent module contains various learning resources such as presentation, text, video, images, and exercise that can be accessed via QR Code reader. This research is a pre-experimental research with one group pretest posttest design. The research subject is 16 students in Department of Physics Education Muhammadiyah University of Makassar. The data were collected through tests of creative thinking skills with indicators of thinking fluency, flexibility, elaboration, and originality. The results of data collection were analysed with descriptive analysis and N-gain test. This research shows that the hypercontent module is effective to improve the creative thinking skills of prospective physics teachers. This can be seen from the increase in the score of students' creative thinking skills from 64.51 to 72.64 after implementing the hypercontent module.

1. Introduction
Entering the era of the industrial revolution 4.0, advanced technology has changed the pattern of human life activities in various fields, including education. This is certainly concern for the community as human resources who will carry out the educational process at various levels of educational units. The field of education which is influenced by the industrial revolution 4.0 is characterized by the use of digital technology in the learning process that can take place continuously anywhere and anytime because without space and time limitations. The use of information technology in education in the era of the industrial revolution 4.0 is carried out as an effort to improve the quality of the learning process in preparing superior human resources with global competence and able to adapt to the current era. The era of the industrial revolution 4.0 brings people to the 21st century learning era where the main focus is to produce human resources who are not only superior in the cognitive aspects, but also able to develop non-cognitive aspects so that they are able to succeed in their future lives and careers. This is characterized by the skills that must be have in the 21st century, including the ability to communicate, collaborate, critical thinking, and creative thinking. Someone who are able to compete in the future are
not those who only rely on their intelligence but are able to use their intelligence to generate new ideas in problem solving as a form of creativity. Creativity is a set of characteristics that allow individuals to solve problems and generate new ideas in a specific context [1]. Many humans are intelligent, but not necessarily creative, so a person's ability to solve problems one of them can be determined by his ability to think creatively. Every human is a creative, external stimuli is essential to encourage human creativity, so it can be optimized through learning and habituation [2].

Creative thinking skills is the ability to develop unusual ideas, quality, and according to the task [3]. Physics learning is complex and broad if taught by just memorizing it. This can cause a decrease in learning motivation which has an impact on decreasing students' thinking abilities, even though it requires creative thinking in the process of solving physics problems. Usable indicators to evaluate creative thinking skill is the fluency that is the number of ideas generated, the flexibility that the number of variations of the idea developed, elaboration is the amount of detail of an idea is developed, and originality that is the extent of the uniqueness of ideas generated [4]. It’s means that creative person is able to solve problems through various kinds of alternative thoughts in the form of unique ideas and the broadest way. Creativity is not a talent or an inborn trait, but it can be obtained from the learning process and habituation which can be developed and applied in thinking activities. In the Vygotsky’s theory, imagination in the cognitive and affective aspects is considered very important to improve creative thinking that is integrated into the learning curriculum [5]. This can be done by applying technological literacy in the learning process to train students' thinking skills in generating new ideas that are innovative. The use of technology can help thinking skills to solve problems [6]. Especially nowadays, students are fond mobile devices as the source of all the information they want. One of the applications of technological literacy in learning is by implementing a hypercontent module.

As one of the device learning based on Technological Pedagogical Content Knowledge (TPACK), the hypercontent module provides learning resources that integrate technology, material content knowledge, and pedagogical elements in one module. The TPACK approach can be integrated into the learning process to train students to discover new knowledge independently [7]. Based on this, it can be assumed that the TPACK approach is considered capable of training creative thinking skills through the process of finding new things to be processed into information through thinking activities. Device learning based on TPACK is the basis of teaching in the form of knowledge about how technology can be used to build knowledge in developing new methods or ways or reinforce old knowledge [8]. In other words, technology can help someone to open their minds to generate various kinds of unique ideas or strengthen existing ideas to be developed again. TPACK learning is one of digital literacy in learning. Digital literacy requires the ability to adapt and changes with media and technology which is computational to communication [9]. Design of hypercontent module is equipped with a QR code as a learning navigation tool that is open source for learning, so that students can choose the QR code to be access based on their wants and needs. The hypercontent module contains a variety of learning resources such as presentation files, website addresses, text, video, audio, images, and practice questions that can be accessed through the QR Code reader application, so that students can choose learning materials that are considered important or interesting to study. It’s means, learning is flexible because students can study anytime and anywhere with a minimalist module, so it doesn't feel boring.

Hypercontent module has a special characteristic that each module’s unit is designed independently so that categorized as self-contained learning [10]. So that students can learn the material content randomly or start and end any unit. The structure of the module material content is packaged in the form of a QR code made with a message design containing theoretical studies, tests, and material from cyberspace through hyperlinks to certain site. QR codes have a higher data storage capacity for storing information in the form of URL codes that are linked to certain web pages. At the time accessed by the application of QR code reader, a mobile device screen will show the address of the link and the user can decide whether to open or not on the browser application [11]. QR codes can facilitate learning by presenting the reality of learning objects in the form of images, audio, text, and animation or learning...
videos in detail, so that they look practical and interesting [12]. QR code is used as a navigation tool that creates learning material content, so that the module can present real learning that can be accessed anytime and anywhere via student’s mobile devices. Learning becomes more interesting without thick modules that can make students feel bored studying. Through the hypercontent module, it is hoped that students can reach knowledge from the learning materials content by technology. Thus, they can achieve success in their life and career in the future through their creativity in solving problems.

2. Method
This type of study is pre-experimental research, which aims to analyze the effectiveness of using the hypercontent module to improve creative thinking skills of prospective physics teachers with one group pretest postest design. In pre-experimental research with one group pretest postest design was given a pretest before treatment, so that the treatment results can be found more accurately because it can compare with the situation before being given treatment [13]. Pre-experimental research with one group pretest postest design implemented through three main stages of research, which is holding a pretest to measure the dependent variable, implementing treatment or experiment, and holding a postest to measure the results or impact on the dependent variable [14]. The data were collected through tests of creative thinking skills with indicators of thinking fluency, flexibility, elaboration, and originality.

In this study, before the research subjects namely 16 students in Department of Physics Education Muhammadiyah University of Makassar were given treatment in the form of giving hypercontent modules, the researcher first made observations in the form of a preliminary test of students' creative thinking skills. Then the treatment or experiment is carried out with implementation of learning using the hypercontent module for four meetings. After that, re-observation was held in the form of postest of the student's creative thinking skills. The difference in the results of the pretest and postest shows the effectiveness of giving hypercontent modules on students' creative thinking skills. The results of data collection continued with data analysis in the form of descriptive analysis to describe students' creative thinking skills and the N-gain test to see how much the index difference between the pretest and postest.

3. Result and Discussion

3.1. Research result
Based on the results of data collection, the scores for the pretest and postest of students' creative thinking skills were obtained. The data is then analyzed descriptively with the aim of describing the condition of students' creative thinking skills without making conclusions but only explaining the data group. The result of descriptive statistics show the average score of research subjects before and after being applied hypercontent module. Table 1 shows the results of a descriptive analysis of students' creative thinking skills in Department of Physics Education Muhammadiyah University of Makassar.

| Statistics   | Pretest | Postest |
|--------------|---------|---------|
| Subject      | 16      | 16      |
| Ideal score  | 100     | 100     |
| Highest score| 69.00   | 87.00   |
| Lowest score | 55.75   | 68.00   |
| Average score| 64.51   | 77.64   |
Table 1 shows the increase of students' creative thinking skills before and after being given hypercontent modules in the learning process. Although the increase is not very significant, but it looks that the standard of the lowest and highest score that can be achieved by the students before and after the implementation of hypercontent module be more better. In addition, the increase was also clearly seen from the average score of students' creative thinking skills is 64.51 before and 77.64 when the hypercontent module was implemented. Technology based learning is certainly a new thing for students so that it seems interesting and students' curiosity becomes better. This is one of the implications of implementing the innovative learning model used by lecturers. This is consistent with the results of research showing the effectiveness of learning by students and lecturers will be better if it is supported by technology than traditional learning. Thus, lecturers and students must be trained to use technology in learning, one of which is the use of hypercontent modules [12]. Therefore, learning by technological literacy will be more interesting, so that it has implications for the ranking of one’s knowledge acquisition.

Figure 1 shows a categorization diagram of students' creative thinking skills scores to see the distribution of scores at the pretest and postest.

![Figure 1](image)

**Figure 1.** Categorization diagram of students' creative thinking skills scores at the pretest and postest

Figure 1 shows that based on the standard categorization of each score at the pretest and postest, it can be seen that even when postest students who are in the very low, low and medium score categories are increasing and students who are in the very high score category decrease, even though the average score is increases. This is due to the different standards of the lowest and highest scores, so that the categorization is different. Even so, the increase in creative thinking skills is clearly seen from the increase in the lowest standard score from 55.75 to 68.00 and the highest standard score from 69.00 to 87.00. The graph also shows the distribution of students who have the same high score category before and after treatment. The increase in the standard score of the categorization shows an interest in the hypercontent module even though the real character is clearly visible.
Table 2. Category gain index of students' creative thinking skills scores

| Criteria | Gain index requirement | Gain index |
|----------|------------------------|------------|
| High     | $g > 0.70$             | 0.369      |
| Medium   | $0.70 \geq g \geq 0.30$|            |
| Low      | $g < 0.30$             |            |

Table 2 shows that index gain of students' creative thinking skills is in moderate category with an index gain of 0.369. It is revealed that the hypercontent module is effective to improve creative thinking skills even though the increase is still in the medium category. In other words, the increase in students' creative thinking skills was not so significant when the hypercontent module was applied. The research results also show that the hypercontent module has not been used in real time to support learning even though it has provided a basic overview in facilitating learning [10]. Thus, the hypercontent module can be an alternative in the 21st century learning, but it still needs improvement from various aspects. Further research is needed on the application of hypercontent modules to be able to make a greater contribution to improve quality of learning process.

3.2. Discussion

Hypercontent module is one of device learning based on TPACK consisting of several sheets contain chapters matter of learning made as efficient as possible and include some of the QR code into the navigation tools so that students can access the unit content material at random according to the needs and desires of student. QR code contains learning resources in the form of presentation files, website addresses, text, video, audio, images, and practice questions that can be accessed through the QR Code reader application. Thus, modules look more attractive and less boring when compared to ordinary modules which contain only text and images and tend to be thick.

The application of the hypercontent module is expected to have implications in the form of improving students' thinking skills through the process of discovering new knowledge from various learning sources that are seen as learning realities. Students also can learn anytime and anywhere just with access the QR Code on the hypercontent module. This accordance with the results of research which shows that the use of QR codes on smartphones can facilitate access to information which is a form of a new paradigm in learning [15]. Although it was only implemented for four meetings, the increase has been seen by an increase in the lowest and highest standards score achieved by students before and after implementation of hypercontent module. Before being treated by application of the hypercontent module in the learning process, the lowest score of creative thinking skills achieved by students was only 55.75, increasing after being given the treatment to 68.00. The highest score achieved by students before treatment increased from 69.00 to 87.00 after being given treatment. The increase was also seen from the average score which increased from 64.51 to 77.64. One of the factors that can cause the lack of improvement in student creative thinking skills that students were not accustomed to using QR codes in learning. The use of QR codes in learning still needs to be further introduced because based on the findings that more than 80% of students recognize QR codes, only half of them have used QR codes before [16]. Although the increase is still in a medium category, but it shows the implications of the use of the hypercontent module in the learning process especially in students' creative thinking skills at Department of Physics Education Muhammadiyah University of Makassar. This can be caused by material content packaged in QR Code on the hypercontent module can facilitate various kinds of student learning styles which of course differ. If students like watching, the hypercontent module provides presentation media and videos for students with visual and audio visual learning styles. If students are happy with practicing an experiment, the hypercontent module can present simple experimental videos for students with a kinesthetic learning style. Through the hypercontent module, students can access many learning resources so that they practice thinking skills to process new information or get new ideas as a form of creativity. The hypercontent module can be
an alternative solution in the selection of innovative learning strategies that lead to 21st century learning, because after studying the hypercontent module students must be able to sort out the information obtained through critical and creative thinking to get the most appropriate knowledge in solving various problems in learning physics.

4. Conclusion
Based on the results research related to the effectiveness of using the hypercontent module to improve creative thinking skills of students in Department of Physics Education Muhammadiyah University of Makassar, it can be concluded that there is an increase of students' creative thinking skills after being taught using the hypercontent module with a gain index of 0.369 with medium criteria. The increase of students' creative thinking skills was not so significant due to the limited number of meetings so that the implementation was not optimal. However, the average score of creative thinking skills increased from 64.51 to 77.64. Thus, the hypercontent module can be considered effective for maximizing students' ability to understand content material learning, improving the quality of learning through the use of technology and making course presentation more attractive.

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