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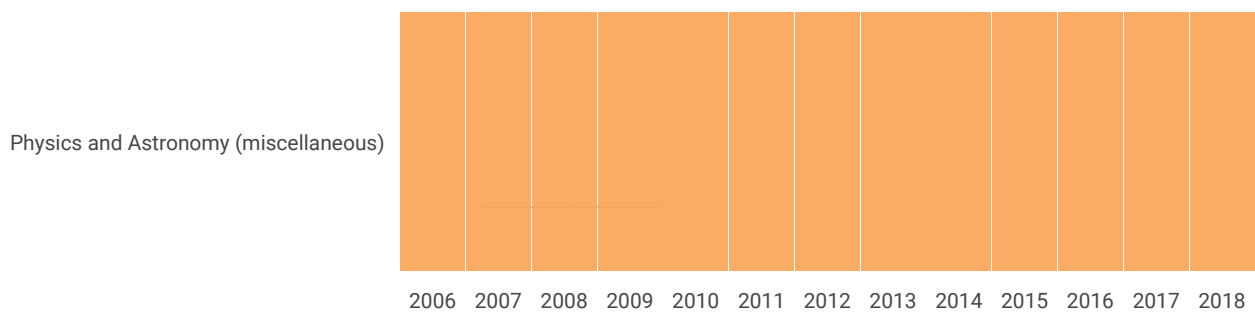
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# The use of an android-based-game in the team assisted individualization to improve students' creativity and cognitive achievement in chemistry

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**Abstract.** The use of information and communication technology (ICT) in learning process resulted in positive impact to students' output. This research investigated the difference of improvement of students' creativity and cognitive achievement due to the use of android-based games on Chemistry Nomenclature in learning method of team-assisted individualization (TAI) into the improvement of students' creativity and cognitive achievement. This was an quasi experiment research with non-equivalent pretest-posttest control group design involving 2 groups of students of X grade of a senior high school in Yogyakarta, Indonesia, SMAN 1 Seyegan, Sleman. The groups were experiment and control which were chosen randomly, involving 32 students in each group. The difference of learning model in the two groups were the use of android-based games within learning model of TAI in the experiment group, but it was only the use of TAI model in control group. The android-based games were developed and validated previously in this investigation, and were excellent in quality for the use in Chemistry learning process, and were reported separately. The data of both students' creativity and cognitive achievement were measured before and after learning process. Data of students' creativity were collected with the instruments of questionnaire and observation sheets, and the data of cognitive achievement were collected with a set of test. Statistical analysis of MANOVA was used to analyze data to measure the difference of the improvement of students' creativity and cognitive achievement between experiment and control groups. The results showed that the improvement of creativity and cognitive achievement of students in the experiment group was higher significantly than that in control group.

## 1. Introduction

Lifelong learning can occur at anywhere and anytime. Learning process can be conducted and obtained from the formal environment as usually done, but it can be from informal situation. Infrastructure and facilities to support lifelong learning for students should be provided by combining formal and informal learning environment to result in optimum outcome [1]. Experience in the formal learning environment has been gained by all students in the school in Indonesia through face-to-face process of teaching and learning. While in the informal learning, learners can gain learning experience from various facilities, including mobile devices to encourage and to support learning process and activities. Mobile devices offer the possibility of spontaneous learning with unstructured situations [1]. In addition, mobile technologies should be viewed as media that can be utilized in an informal



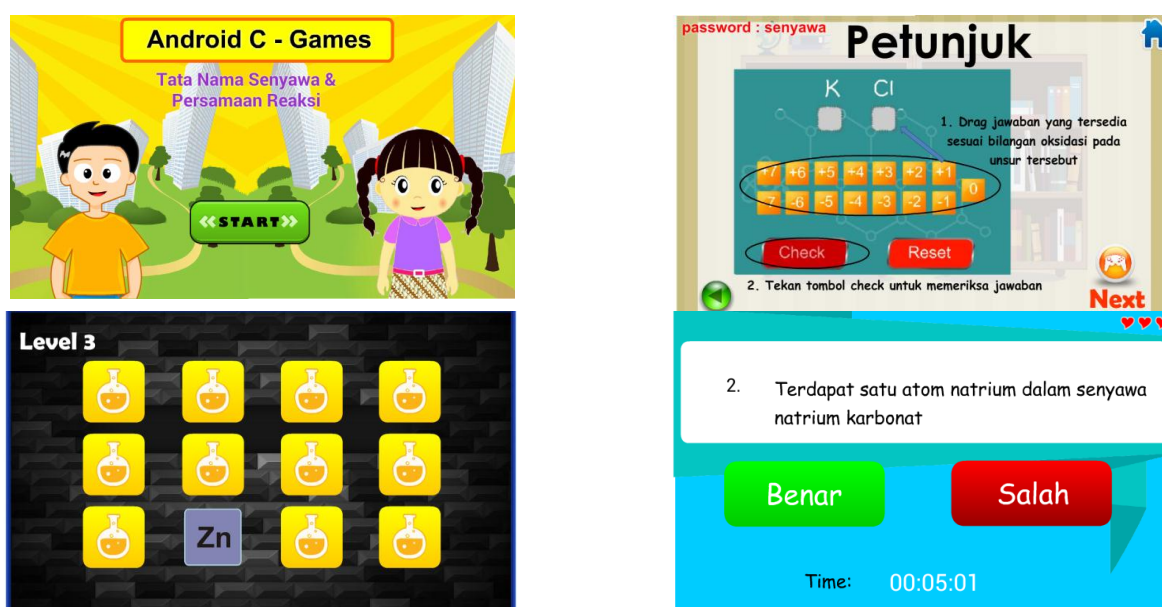


learning activity and can be elaborated in learning scenarios [2]. Mobile devices offer new opportunities to create a flexible, diverse and interactive learning environment, and enable lifelong learning possible by anyone from anywhere. The advantages of the use of mobile devices as learning tools should encourage educators to develop mobile based instructional media. It is due to large number of mobile phone users in Indonesia, including senior high school students. The media can be used as instructional media for independent learning activities to improve cognitive learning achievement and creativity of students. Sawyer (2006) argued that creativity is an important factor in both formal and informal learning [3]. Peters [4] stated:

*"Much of the literature concerning education and the creativity and the prototype of economic development and the need for building forms of cultural, social, and public entrepreneurship. The problem is that beyond the formulation of concepts such as 'creative cities', 'creative cities', and 'creative classes', have been made of creativity in schools apart from frosting instrumental version of creativity or simply regarding 'education, training, And skills' as one aspect of the creative economy"*.

From the observation in some schools in Yogyakarta, student' creativity need to be improved. Improvement of creativity is important to provide creative learning for students [4], and to enhance better learning outcome. Cheung (2012) stated that there were two issues that must be considered to achieve creativity in education, (1) teachers' creative meaning and (2) practices of teachers' creativity in the classroom [5]. Simonton (2012) stated that to convey creative learning in the classroom, a teacher should be able to make students "surprised", such as wearing T-shirts related to learning materials to be delivered [6]. An alternative solution to improve students' creativity is learning a topic with assistance of an android-based media. Android instructional media can stimulate students to do exercises enjoyably. With the android-based media, students are challenged to play and to learn the game in several levels as students learning speed.

In this global era, android games are widely available in market and can be downloaded freely. The android-based instructional media used in this research is also available in Play Store, with keyword of search "Chemondro". The media were developed based on Indonesian latest curriculum, "2013 Curriculum". The quality of media was considered to be excellent for the use in Chemistry learning, based on the reviews of three experts; expert of learning media, of learning subject materials, and chemistry teachers, as well as based on the responses of students as a step of the implementation in the research and development model. The screen capture of the example of some menus in the android-based-game implemented in this research was given in Figure 1.



**Figure 1.** Screen Capture of Android-Based-Games Developed and Used

The media have characteristics as follows: (1) the instructional media is an application with the file extension of apk. The media can be played by Android-OS devices, (2) the content of media is Nomenclatures of Chemical Compounds for grade X of senior high schools (SMA), (3) the media can be used both in a face-to-face classroom learning and in a non-face-to-face chemistry learning activities, (4) the media are able to visualize learning materials. Thus, the use of android instructional media that was developed can make students gain better comprehension of chemical compound nomenclature with fun and easy. This research investigated the effect of the use of android instructional media to the improvement of high school students' creativity and learning achievement.

## 2. Method

This research is a quasi-experimental design, with non-equivalent control-experiment group design. The population was Grade X senior high school students (SMA) in Yogyakarta, with the sample consisted of 64 students from 2 classes of Grade X, SMA N 1 Seyegan, control class and experiment classes. Those 2 classes as the samples were determined by random sampling. Learning was conducted following the lesson plan on Compound Nomenclature that was written based on the 2013 Curriculum, and was integrated into learning model of the TAI. Learning activities in both experiment and control groups were carried out with the same number of meetings, materials, learning methods and models, as well as evaluation. The different treatment in the 2 classes and research design are shown in Table 1.

**Table 1.** Non Equivalent Control-Experiment Group Design

Variable	Students Group	Pre-test	Treatment		Post-test
			Team Assisted Individualization	Android-based instructional media	
Creativity	Experiment	Yes	Yes	Yes	Yes
	Control	Yes	Yes	No	Yes
Cognitive	Experiment	Yes	Yes	Yes	Yes
	Control	Yes	Yes	No	Yes

### 2.1. Data Collection Instrument

The instruments used in this study were (1) questionnaires of creativity for students answered observation sheet to assess students' creativity during the face-to-face learning in the classroom, (2) a learning outcome test with a type of reasonable multiple-choice questions to measure students' cognitive achievement, and (3) a teacher's observation sheet to confirm the process of learning as on the lesson plan.

Learning outcomes and creativity of students from both experiment and control groups were accessed twice; e.g. through pre-test and post-test. Improvement of learning creativity and cognitive achievement was analysed using normality test of gain values. The normality test of the gain of each variable, students' cognitive achievement or creativity can be calculated using the following equation [7].

$$g = \frac{S_f - S_i}{100 - S_i}$$

Note: Sf = final test  
Si = initial test  
g = gain

The interpretation of the criteria of the gain of students' learning creativity and cognitive achievement was based on the gain value with the criteria was presented in Table 2 [7].

**Table 2.** Gain Value Criteria

Gain Value	Criteria
$G \geq 0.70$	High
$0.30 \leq g < 0.70$	Medium
$G < 0.30$	Low

The difference of learning creativity and cognitive achievement of students from control and experiment groups; because of the use of android-based games on Chemistry Nomenclature which was integrated into the learning method of TAI was statistically analysed using Multivariate Analysis of the Variance (MANOVA) using SPSS V.23. The test of normality and homogeneity toward the data of creativity and learning achievement was completed before the analysis of MANOVA was applied. The normality test was performed using Mahalonobis value using SPSS V.23. The Mahalonobis value obtained was then compared with *chi* (*q*) value. Data was considered normal at significance level of 0.05 when 40-60% of the data in each group has Mahalonobis values less than *chi* (*q*) values.

The homogeneity test conducted was a homogeneity test of dependent variable variance-covariance simultaneously. Data for homogeneity test was the data of creativity increase (gain) and cognitive learning outcomes of the students. The variance-covariance homogeneity test for the data was performed by Box's M test by use of the computer program, SPSS V.23. The matrix of variance-covariance was considered homogeneous if the *sig.* value  $> \alpha$ . MANOVA analysis was performed to answer the research statistical hypotheses as following:

$H_o$ : There is not any significant difference in the improvement of creativity (Y1) and learning outcomes (Y2) between students who learnt with Android-based instructional media using TAI learning model and those with LKS (Student Worksheet) using TAI learning model.

$H_a$ : There is significant difference in the improvement of creativity (Y1) and learning outcomes (Y2) students who learn with Android-based instructional media using TAI learning model and those with LKS using TAI learning model.

### 3. Result and Discussion

The android-based game that was good in quality based on the reviews of media expert, material expert, chemistry teachers and students especially on the aspects of learning, materials, language, audio visual and software engineering was used in Chemistry learning. The Learning process was performed by utilizing android-based game in the integrated TAI, and the effect of learning was compared to that of learning without the use of android-based game. The data of learning achievement from both pre-test and post-test are given in Table 3.

**Table 3.** Students' Learning Achievement (Pre-test and Post-test)

Class	Total Student	Pretest		Post-test		gain	category
		Average Value	completeness (%)	Average value	completeness (%)		
Experimental	32	6.125	0	87.06	100	0.862	High
Control	32	5.156	0	83.25	96.8	0.82	High

Table 3 shows an increase of the average value of pre-test and post-test of students from both experimental and control classes; from 6.125 to 87.06 for the experimental class, and from 5.156 to 83.25 for the control class. It means that the gain of students' achievement in the experimental class which utilizes android-based game was higher than that in the control class. Students' learning by utilizing the android-based game integrated to TAI model gained significant results. This is because the instructional media can stimulate students' motivation and assist students to understand learning

materials. This was stated by Sakat *et.al.* (2012) that the use of technology-based media can improve cognitive learning outcomes [8]. Media can also facilitate teachers to better deliver learning materials. The same thing was also reported by Jabbour (2014) that the use of mobile learning can result in the increase of students' outcomes [9].

The field test as an important step in the research and development model was also performed to check the improvement of students' learning creativity and cognitive achievement in both experimental and control classes before and after learning process. The data of creativity improvement were collected both by observation during learning process and by a set of questionnaire that was validated constructively and logically by expert. Results of the observation were qualitative data in the form of average increase from the whole students. Data of the questionnaires on students' learning creativity were presented in Table 4.

**Table 4.** Data of Students' Creativity

Class	Total Student	Pretest		Post-test		gain	category
		Average Value	completeness (%)	Average value	completeness (%)		
Experimental	32	122.34	74.90	133.1	88.72	0.55	Medium
Control	32	103.41	68.94	124.03	82.69	0.44	Medium

Table 4 shows an increase of creativity of students from both classes. In the experimental class there is a gain of 0.55 which is considered as medium gain category, while in the control class there was a gain of 0.44 which was medium gain category too. Those data show that the experimental class has higher students' creativity improvement than the control class does. The use of android-based game using the learning model of TAI in the learning process resulted in the increase of cognitive learning outcomes and a better creativity than without using the android-based game. This is in line with the finding by Ulfa *et.al.* (2017) that there was an increase in creativity and cognitive learning outcomes between students who using the android-based chemistry instructional media integrated into Learning Together and those who use Learning together without the android-based instructional media [10].

### 3.1. Analysis of Prerequisite Test

Analysis of prerequisite tests included data normality and population homogeneity. Normality test was performed on N-gain from data of the improvement of students' learning creativity and cognitive achievement of students from both the experimental and control classes. The Mahalanobis value resulted from the SPSS program in each class can be seen in Table 5

**Table 5.** Analysis of Multivariate Normality

Class	Percentage $d_i^2 \leq \chi_{p,0.5}^2$	Conclusion
Experimental	46.875%	Normally Distributed
Control	53.125%	Normally Distributed

Based on the above listed in the Table 5, it can be noticed that Mahalanobis value was  $\leq$  chi squared value or  $d_i^2 \leq \chi_{p,0.5}^2$  (1,38) was in the range of 40 - 60%, which can be concluded that data were multivariate normally distributed.

Homogeneity analysis was done using SPSS program. Results of the homogeneity test can be seen in Table 6.

**Table 6.** Analysis of Multivariate Normality

Effect	Significance	Conclusion
<i>Box's M</i>	0.298	Homogeneous Data

The Box's M test obtained a significant value greater than 0.05, so it can be concluded that the variance-covariance matrix of the population is the same or homogeneous.

### 3.2. Hypothesis Testing

After the normality and homogeneity prerequisite tests were done, the hypothesis. This hypothesis analysis was performed, to study the difference in creativity and learning outcomes between students who learnt with Android-based instructional media using TAI learning model with those with LKS (print out students' sheet) using TAI learning model. The conclusion whether the hypothesis was significant or not was obtained by interpreting the value of Manova significance from the calculation obtained from SPSS program. If the value of significance is  $<0.05$  ( $p < 0.05$ ), then  $H_0$  is rejected and  $H_a$  is accepted. Hypothesis testing was done using N-gain data obtained from data of the increase of students' creativity and cognitive learning outcomes with SPSS. The analysis results of Manova test are presented in Table 7.

**Table 7.** Manova Analysis Results

Effect	Significance	Explanation	Conclusion
Hotelling's Trace	0.039	$H_0$ is rejected	There is a difference in the increase of creativity and cognitive learning outcomes

TAI learning model was able to support and to enrich face-to-face learning in the classroom. It was able to transform learning from teacher-centered to student-centered. Thus, it brings about the improvement of creativity and cognitive achievement of students. The media included learning materials of introduction game or basic learning materials which should be learnt and mastered by students first. The game required students to learn the introduction games and basic materials before continuing to higher level of learning materials and game. On the last game, students were facilitated to play games with competition among the other students. It made the students more enthusiastic and challenged. Based on this study, learning process was expected to be more varieties and enjoyable, by combining TAI model with android-based-game. Therefore, students were expected can understand Chemistry materials better.

## 4. Conclusion

The use of android based media on the Nomenclature of Compound in TAI learning model can bring about higher students' gain of creativity and learning achievement compared to that who used worksheet (LKS) in TAI learning model.

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