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Our journal has been published for over eight years. It has been followed by many people and a lot of articles have been sent to be published. 531 articles have been sent to referees for forthcoming issues. They will be published according to the order and the results. Articles are sent to referees without names and addresses of the authors. The articles who get positive responses will be published and the authors will be informed. The articles who are not accepted to be published will be returned to their authors.

We wish you success in your studies.

Cordially,

1st July, 2019

Editor
Prof. Dr. Zeki Kaya, Gazi University, Ankara- Turkey

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ARTICLES

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STUDENTS' CONCEPT UNDERSTANDING IN CHEMISTRY LEARNING USING MACROMEDIA FLASH BASED INQUIRY LEARNING

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Abstract
This research aimed at describing the effectiveness of the macromedia flash based inquiry learning in improving students' concept understanding in chemistry learning. It was an experimental research with post-test only design. The population was the eleventh-grade science students of state high school 5 Yogyakarta, Indonesia. The sample in this research was taken by random sampling technique as many as two groups, namely the experimental group and control group. The students in the experimental group learned through the macromedia flash based inquiry learning, while students in the control group learned through the conventional learning. The data on the students' concept understanding were collected through the concept understanding test. The data were analyzed by using one-way ANOVA with SPSS version 23.0. The results showed that students who used macromedia flash based inquiry learning in the assessment process have increased concept understanding better than those used conventional learning (value of significant < 0.05).

Keywords: concept understanding, guided inquiry, macromedia flash, chemistry learning

INTRODUCTION

Education according to the national education system is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation , and country. Education has an important role in improving human resources (Republik Indonesia, 2003). However, the United Nations Development Program (UNDP) in the report of the 2016 Human Development Report noted that Indonesia's Human Development Index (HDI) in 2015 was ranked 113, down from 110 in 2014. The causes of low quality education in Indonesia include problems of effectiveness, efficiency, creativity and standardization of teaching / learning (Fauzi, 2017).

Good learning is learning that includes unlimited learning experiences, ideas and emotions interact with the classroom atmosphere (Joyce, Weil, & Calhoun, 2009: 6). Chemical learning is learning that develops the competencies of students in order to be able to explore and understand chemical concepts systematically through a deeper learning experience (Suyanti, 2010:175). Students are required to actively apply knowledge to self-development. Chemistry learning emphasizes that students learn actively and learning experience can directly improve understanding of concepts and process skills, so that students can meet the standards of graduate competence (Chairam, Klahan, & Coll, 2015). The results of several studies conducted on students in chemistry learning showed that the understanding of students' concepts was low as indicated by the test scores and low national examination scores; students are less enthusiastic and lack interest in learning; teacher-centred learning; and learning is unpleasant and boring, so chemistry is considered a difficult subject for students (Anisa & Yuliyanto, 2017; Jusniar, 2016; and Fakhrurrazi, Masykuri, & Sarwanto, 2017).

Learning models are conceptual frameworks that describe systematic procedures in organizing learning experiences to achieve learning goals (Joyce, Weil, & Calhoun, 2009: 30). Inquiry learning

model involves students actively in finding and discovering their knowledge. The role of educators in the inquiry learning model as a facilitator and guide the course of learning (Tatsuoka, Shigedomi, & Koga, 2015: 1526). Inquiry learning model based on the level of dominance of the role of teachers and students is grouped into 4 types, namely demonstration inquiry, structured inquiry, guided inquiry, and full inquiry (Llewelly, 2007: 101). Differences in the level of inquiry based on the degree of dominance of teacher and student roles are shown in Table 1. In this study used a guided inquiry learning model. In guided inquiry learning the teacher provides a formulation of the problem of the investigation, and the students design an investigation procedure, conduct an investigation to test the problem of the investigation and produce an explanation. Inquiry learning is more successful if students have the opportunity to learn and practice designing experiments and recording data. The role of the teacher in this learning model is to direct students who need guidance in designing and implementing experiments (Banchi & Bell, 2008: 28). However, based on several research results, it is shown that in chemistry learning the use of learning models is less varied and the teacher as a source of knowledge (lack of references from other learning sources) (Anisa & Yuliyanto, 2017; Jusniar, 2016; and Fakhrurrazi, Masykuri, & Sarwanto, 2017).

Tabel 1: Level of Inquiry According to Llewellyn (2007)

	Demonstration Inquiry	Structured Inquiry	Guided Inquiry	Full Inquiry
Question	Teacher	Teacher	Teacher	Students
Procedure	Teacher	Teacher	Students	Students
Analysis	Teacher	Students	Students	Students

Chemical learning can achieve maximum results if there is media use in learning. One of the media used is computer-based media such as Macromedia Flash. Macromedia flash is the right media to display visualization of learning. Macromedia flash attracts students 'attention, so students like chemistry lessons and understanding students' chemical concepts increases. Learning that uses computer media effectively helps students to understand chemical concepts that are abstract in nature and can minimize misunderstandings that may occur (Talib, Matthews, & Secombe, 2005). However, based on several research results, it is shown that in chemistry learning the use of media is not as optimal as the use of multimedia and laboratories (Anisa & Yuliyanto, 2017; Jusniar, 2016; and Fakhrurrazi, Masykuri, & Sarwanto, 2017). Teacher-centered learning activities, less varied, and less optimal use of media make students less developed understanding of concepts and various skills possessed by students (widjajanti, Rohaeti, Isana, 2010 and Sutarno, Setiawan, & Kaniawati, 2016).
The cognitive process that rests on the ability to transfer and emphasizes schools and colleges is understanding. Students are said to understand if they can construct the meaning of learning messages. Learners understand when connecting new and old knowledge they have. Conceptual knowledge (knowledge that is more complex and organized) is the basis for understanding. One of the indicators of success in the learning process is understanding concepts. Understanding the concepts of students seen from the scores of learning outcomes obtained. Students who understand the concept of good learning generally have a high learning outcome score. Cognitive processes in understanding categories include interpreting, exemplifying, classifying, summarizing, concluding, comparing, and explaining (Anderson & Krathwohl, 2010: 105). However, based on the PAMER UN application (Operation of the Application for the Utilization of National Examination Results) the results of the high school national chemistry examination in 34 provinces in Indonesia in the 2016/2017 academic year show that the national average chemical value is 53.05. This shows that students' understanding of the chemical concepts is still low.

Chemical equilibrium material is one of the chemical materials that must be studied and mastered by students in class XI High School to achieve graduate competency standards that must be possessed by students (Presiden Republik Indonesia, 2016). However, based on research conducted by Indriani, Suryadharma, & Yahmin (2017), it shows that students' understanding of chemical equilibrium material is still low, this causes students to experience difficulties in understanding chemical material that requires knowledge of chemical equilibrium prerequisites. In addition, research conducted by

Haryani, Prasetya, & Saptarini (2014) shows that in chemical equilibrium materials, teachers experience difficulties in mastering concepts and prospective teachers have difficulty in teaching students.

This shows that media use has not been maximized and students' chemical concepts understanding is still poor. Therefore this research applies macromedia flash based inquiry learning in chemistry learning to improve students' concept understanding in chemical equilibrium material. This is the reason why this research was conducted.

METHODS

Research Design

This research used the experimental method with post-test only design. The form design is shown in Table 2 (Cresswell, 2012). The research was begun by developing the learning tools by referring to the 4D (Define, Design, Develop, and Disseminated) model of Thiagarajan, Semmel, & Semmel (1974). In the developing stage, the evaluation learning tools were used to conduct the experimental research.

Tabel 2: Research Design

Group	Treatment	Post-Test
Experiment	Inquiry Learning (macromedia flash)	students' concept understanding
Control	Conventional Learning	students' concept understanding

Participants

The population of this research included the eleventh-grade science students of state high school 5 Yogyakarta, Indonesia. The sample was taken by random sampling technique. The sample included 70 students; 34 students as the experimental group and 36 students as the control group. The students in the experimental group learned through the macromedia flash based inquiry learning, while students in the control group learned through the conventional learning. This research was conducted in the odd semester on academic year 2018/2019.

Data Collection

The data of this research were the scores of the students' concept understanding, which were collected using the concept understanding test; 20 items of objective test. The concept understanding test was developed from cognitive processes in categories understanding. The seven items indicators assessed in this research is interpreting, modeling, classifying, summarizing, concluding, comparing, and explaining.

Data Analysis

The data were analyzed using one-way ANOVA with the help of SPSS version 23.0. The inferential analysis was conducted with a 5% significance level. The normality of data distribution was tested using the Shapiro-Wilk Test. the homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances.

FINDINGS

Students' concept understanding in chemistry learning using macromedia flash based inquiry learning. The chemical material in macromedia flash is a chemical equilibrium material. Macromedia flash used in this research was made using the ispring suite 8 application. The display macromedia flash can be seen in Figure 1.

The concept understanding of the students who learned using the macromedia flash based inquiry learning were better than those obtained through the conventional learning. The average score of

concept understanding of the students who learned through the macromedia flash based inquiry learning was 76.47, while the student who learned through the conventional learning was 68.33. The distribution of the students' concept understanding is shown in Table 3. The post test scores in experiment group and control group are showed in Figure 2.

Table 3 The Distribution of Students' Concept Understanding

Group	Score of Concept Understanding			
	Sum of Samples (N)	Minimum	Maximum	Mean
Experiment	34	45	100	76.47
Control	36	40	100	68.33

Start Page

Main menu

Menu of macromedia flash

Chemical equilibrium material

Game (evaluation questions)

Figure 1: The display macromedia flash

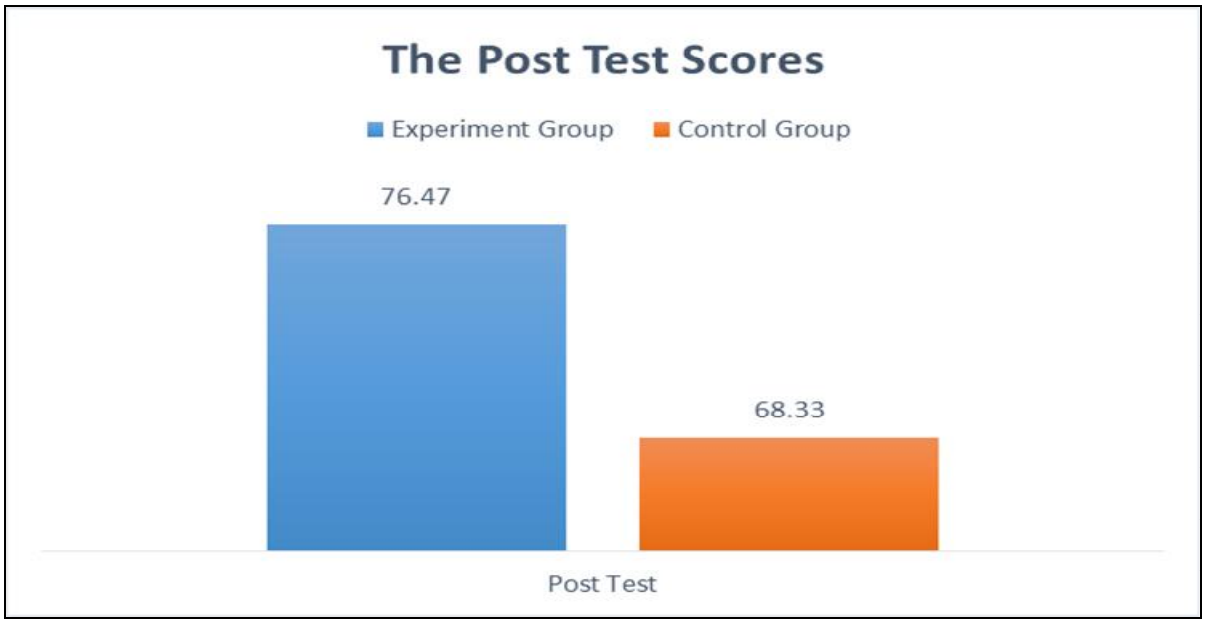

Figure 2: The Post test Scores in Treatment and Control Class Groups

The normality of the data distribution of the concept understanding of the students in the experimental group and control group were tested using the Shapiro-Wilk Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variance. The summary of the result of normality and homogeneity test are shown in Table 4.

Tabel 4: The Summary of The Result of Normality and Homogeneity

Group	Test of Normality			Test of Homogeneity	
	Shapiro-Wilk			Levene Statistic	Sig.
	Statistic	df	Sig.		
Experiment	0.964	34	0.317	2.197	0.143
Control	0.954	36	0.145		

Based on Table 4, the data on the score of the students' concept understanding of the experimental group and control group are normally distributed. This is evidenced by the value of significant from normality test > 0.05 which are equal to 0.317 (experiment group) and 0.145 (control group). Homogeneity of variance data is homogeneous. This is evidence by the value of significant from homogeneity test > 0.05 which is equal to 0.143. Based on the characteristic of the data above, the data on score of the concept understanding can be analyzed using the one-way ANOVA. The summary of the result of analysis using the one-way ANOVA is shown in Table 5.

Tabel 5: The Summary of The Result of One-Way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1157.815	1	1157.815		
Within Groups	18126.471	68	266.566	4.343	0.041
Total	19284.286	69			

Based on Table 5, the value of significant from the one-way ANOVA test is 0.041 < 0.05, meaning that the concept understanding of the students who learned through the macromedia based inquiry learning are significant different from those of the students who learned through the conventional learning. The concept understanding of the students who learned through the macromedia flash

based inquiry learning are better than those of the students who learned through the conventional learning.

DISCUSSION AND CONCLUSION

Discussion

The research showed that the concept understanding of the student who learned through the macromedia flash based inquiry learning were better than those obtained by the students who learned through the conventional learning. Implementation of macromedia flash based inquiry learning has a significant effect on increasing concept understanding of students in chemistry learning. This is evidenced by the value of significant from the one-way ANOVA test < 0.05 which is equal to 0.041, shown in Table 5. Besides, based on the analysis as presented in Table 3 shows the average of concept understanding in experiment group is higher than control group, that are 76.47 in experiment group and 68.33 in control group. The data obtained are normally distributed and homogeneous so that the data can be analyzed using one-way ANOVA with the help SPSS version 23.0, shown in Table 4. The display macromedia flash can be seen in Figure 1. Inquiry learning has a positive effect on concept understanding because the stages of inquiry based learning involve students actively and develop skills (Tatsuoka, Shigedomi, & Koga, 2015: 1526). In the process of learning the students must be empowered to be willing and able to do to enrich their learning experiences by increasing interaction with their environment both physical, social, and cultural environments (Budimansyah, 2003, 3). Chemistry learning emphasizes students' active learning and learning experience can directly improve understanding of concepts and process skills, so that students can meet graduate competency standards (Chairam, Klahan, & Coll, 2015).

Chemistry is the study of matter and its changes. Elements and compounds are substances that are involved in chemical changes (Chang & Overby, 2008: 2). Chemistry studies the building (structure) of matter and the changes experienced by matter in natural processes and in planned experiments (Keenan, Kleinfelter, & Wood, 1984: 2). Compared to other fields, chemistry often seems more difficult, at least at the basic level (Chang & Overby, 2008). Kean & Middlecamp (1985: 5-8) states that the difficulty in studying chemistry is related to the characteristics of chemistry itself, namely: Most concepts and theories in chemistry are abstract, chemistry is a form of simplification of the actual, nature sequential chemistry and its rapid development, chemistry is not just to solve problems, and so much material or material is studied. In addition students consider chemistry difficult subjects because of boring and unpleasant learning activities; students are less enthusiastic about participating in learning so the score of concept understanding is low (Anisa & Yuliyanto, 2017; Jusniar, 2016; and Fakhrurrazi, Masykuri, & Sarwanto, 2017).

The use of macromedia flash in chemistry learning is able to attract and direct students' attention to concentrate on the content of the lesson relating to the visual meaning displayed (Arsyad, 2004). Macromedia flash attracts students' attention, so students like chemistry lessons and students' chemical concepts understandig. Learning that uses computer media effectively helps students to understand chemical concepts that are abstract in nature and can minimize misunderstandings that might occur (Talib, Matthews, & Secombe, 2005). Macromedia flash is a program for making animations, presentations, games and even learning devices with an attractive visual display (Wahyono, 2006). Macromedia flash is the right computer-based media to display abstract visualizations of chemical learning, so that learning activities achieve maximum results / learning objectives. Based on the results of several studies showing that the use of multimedia / macromedia flash can increase interest, activity, learning achievement, attitudes, and understanding students' concepts (Asiyah, Mulyani, & Nurhayati, 2013; Tatli & Ayas, 2013; and Wahyudin, Sutikno, & Isa, 2010).

Learning model is the stage of learning to achieve maximum goals (Gunter, Estes & Schwab, 1990: 67). The learning model is a conceptual and operational framework for learning that has a name, features logical sequences, settings, and culture (Presiden Republik Indonesia, 2014). Inquiry

learning models involve students actively in finding and discovering their knowledge while educators as facilitators and guide the course of learning. Inquiry learning is associated with environmental phenomena that are in accordance with their prior knowledge helping students build new knowledge. In finding and finding answers to a problem students are required to think critically and analytically (Tatsuoka, Shigedomi, & Koga, 2015: 1526). In addition, the inquiry learning model helps students develop intellectual discipline and skilled skills to improve questions and search answers that are hidden from the curiosity of students (Joyce, Weil, & Calhoun, 2009: 202).

Inquiry learning used in this study is guided inquiry learning. The guided inquiry learning model according to Llewellyn (2007: 106) is learning that begins with the teacher giving a question or problem that will be investigated and shows the material or material to be used. Next the students design and carry out the investigation procedure. Students then draw conclusions and arrange explanations of the data collected. The activities of the teacher and students in the guided inquiry learning are shown in Table 6. The stages of guided inquiry learning model are identification and determination of the scope of the problem, planning and predicting results, investigating data collection, interpreting data and developing conclusions, and reflecting. The stages of learning in inquiry learning provide an opportunity for students to learn actively in finding their knowledge (the teacher as a facilitator and overseeing the course of learning), looking for learning resources from various media, developing understanding of concepts, thinking critically, analytically, and process science skills (Chairam, Klahan, & Coll, 2015 and Tatsuoka, Shigedomi, & Koga, 2015: 1526).

Table 6: The activities of the teacher and students in the guided inquiry learning

Learning stages	Teacher Activities	Student Activities
Identification and determination of the scope of the problem	Asking problems to solve or questions to investigate	Defines the nature and parameters of the problem
Plan and predict results	➢ Encourage students to design procedures or means to solve problems or answer questions asked ➢ Encourage students to choose the right tools and materials needed	➢ Brainstorming about alternative procedures and problem solving solutions ➢ Choose or design a problem solving strategy ➢ Choose the tools and materials needed right
Investigation for data collection	➢ Guiding students in conducting investigations and encouraging individual responsibilities of group members ➢ Directing students to utilize other sources of information for problem solving	➢ Implement plans to solve problems ➢ Use science process skills to collect and analyze information ➢ Observe, collect data, communicate, and work with members
Interpret data and develop conclusions	➢ Guide students to organize data ➢ Guide students how to communicate their findings and explanations	➢ Make observational notes ➢ Processing the collected data in the form of graphs and tables ➢ Make patterns of relationships in the data ➢ Draw conclusions and formulate explanations ➢ Communicate the results of the investigation
Feedback	➢ Encourage students to think or reflect on the knowledge they have just discovered	➢ Evaluating the inquiry process that has been carried out ➢ Asking new questions based on the data collected

Based on the results of several studies on inquiry learning, it is shown that inquiry learning is better than conventional learning. The results of the application of inquiry learning are improving understanding of chemical concepts, science process skills, problem solving skills, building self-confidence, independence, increasing the depth of student knowledge and overcoming misunderstandings (Vilardo, Mackenzie, & Yezierski, 2016: 206; Tatsuoka, Shigedomi, & Koga, 2015: 1526; Mistry, Fitzpatrick, & Gorman, 2016: 1091; King, Wang, Yezierski, 2017: 158; Chairam, Klahan, & Coll , 2015: 937). The cognitive process that rests on the ability to transfer and emphasizes schools and colleges is understanding.

One of the indicators of success in the learning process is concepts understanding. Learners more easily solve problems faced in the learning process even in everyday life if they have a good concepts understanding, therefore concepts understanding needs to be developed. One of the goals in chemistry learning is to increase meaningful understanding in chemical concepts. Meaningful learning occurs when students integrate new concepts into their cognitive structure (Chairam, Klahan, & Coll, 2015). Ausubel (Hacieminoglu, 2016) states that integrating concepts continuously will help students gain meaningful learning. Students who are unable to integrate new concepts into their previous knowledge tend to use memorization and express their understanding with concept definitions as isolated facts. Students are said to understand if they can construct the meaning of learning messages, whether oral, written or graphic, delivered through teaching, books, or computer screens. Learners understand when connecting new and old knowledge they have. Cognitive processes in understanding categories include interpreting, modeling, classifying, summarizing, concluding, comparing, and explaining (Anderson & Krathwohl, 2010: 105).

Conventional Learning Models do not provide opportunities for students to be active in learning activities. The teacher as a source of knowledge and students only accept what the teacher says. In conventional learning students are less involved in discovering new concepts / knowledge, teacher-centered learning, students are not stimulated by their curiosity and the use of less optimal learning media such as multimedia and laboratory use. This causes the understanding of concepts and skills possessed by students to be less developed (Anisa & Yuliyanto, 2017; Jusniar, 2016; and Fakhrurrazi, Masykuri, & Sarwanto, 2017).

Although the concept understanding of students who learned through the macromedia flash based inquiry learning were better than those obtained by the student who learned through the conventional learning, the results were not optimal. This was caused by many obstacles in the implementation of the inquiry based learning. The obstacles found in the implementation of the macromedia flash based inquiry learning was difficulty in growing the positive habit of the students to be active, as the learning results from the learning experience before tend to make the students passive. The students must be habituated to follow inquiry learning so that they can develop concept understanding to the fullest.

Conclusion

Based on the results of this research, it can be concluded that the concept understanding of the students who learned through the macromedia flash based inquiry learning were better than those obtained by the students who learned through the conventional learning. The average score of the concept understanding of the students who learned through the macromedia flash based inquiry learning and conventional learning were 76.47 and 68.33, respectively. Implementation macromedia flash based inquiry learning has a significant effect on increasing concept understanding of students in chemistry learning. This evidence by the value of significant from the one-way ANOVA test < 0.05 which is equal to 0.041. The concept understanding developed at chemistry lesson and the topic of chemical equilibrium is interpreting, modeling, classifying, summarizing, concluding, comparing, and explaining.

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MINDFUL MINUTES IN THE CLASSROOM

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Abstract
Mindfulness is being nonjudgmental, accepting, and in the present moment. Approaches based in mindfulness can benefit people of all ages socially, emotionally, and even physically. While mindfulness interventions are beginning to become more popular in the classroom for young children through adolescents, very little research has been conducted using mindfulness techniques in postsecondary classrooms, especially at the graduate level. Therefore, our study aimed to evaluate if a short, weekly mindfulness activity presented to a small group of graduate students could increase overall mindfulness. While statistically significant results were not found, qualitative information shows the group did believe this was a useful intervention. Therefore, several suggestions for future use are provided so more mindfulness activities can be used in classrooms at the graduate level. These techniques used by adults in the classroom can then be used to support the educational community and system-wide interactions.

Keywords: Mindfulness, Postsecondary/ Graduate-level education, Systems-intervention.

INTRODUCTION

Mindfulness involves being present, nonjudgmental and open to experience. It allows us to become more accepting of ourselves as we are right now. According to Harpin, Rossi, Kim, and Swanson (2016), teachers who used a mindfulness program in their classroom have reported significant differences in prosocial behaviors, emotional regulation, and academic performance. Mindfulness education helps students with learning disabilities, decreases the impact of bullying, and helps teach empathy (Leland, 2015). Thus, mindfulness can clearly benefit everyone involved in schools.

Mindfulness and Early Childhood Education

The effects of mindfulness have been studied in many different settings; one such area that includes a substantial amount of research around mindfulness is early childhood education. Studies vary in length, ranging from 6 hours of intervention across a 12-week span to 40 hours of intervention spread out over the course of a year (Viglas & Perlman, 2017; Razza, Bergen-Cico, & Raymond, 2013). Flook, Goldberg, Pinger, & Davidson (2015) examined the effects of implementing a mindfulness-based curriculum in preschool classrooms over the course of 12 weeks, totaling approximately 10 hours of instruction. Results from this study indicate that students who were exposed to the mindfulness curriculum demonstrated increased social competence and higher grades than the control group in the areas of learning, social-emotional development, and health. Another study lasting 6 weeks focused on self-regulation, prosocial behavior, and hyperactivity in kindergarten classrooms (Viglas & Perlman, 2017). Results indicated that kindergarteners in the group receiving mindfulness instruction exhibited significantly stronger self-regulation skills, more improvement in prosocial behavior, and lower levels of hyperactivity. These aforementioned studies show early childhood populations can benefit in several ways from mindfulness approaches in the classroom, even if only used for 6 to 12 weeks.

Longer studies surrounding the area of mindfulness in early childhood demonstrate similar results with overall skill gains; results of a yearlong study evaluating the effects of a mindfulness-based yoga intervention with preschool students suggest overall improvement in the area of self-regulation, particularly in the areas of attention, delay of gratification, and inhibitory control (Razza et al., 2013). Lemberger-Truelove, Carbonneau, Atencio, Zieher, & Palacios (2018) also found significant improvement in the areas surrounding self-regulation and orientation to experience (e.g., experience in the present moment). Overall, the early childhood mindfulness studies show skill gains particularly with social-emotional development and well-being.

Mindfulness and Elementary Education

Many mindfulness interventions have been carried out at the elementary level with similar results to those done in early childhood. Some interventions are carried out in urban schools, specifically choosing student populations that are culturally diverse and predominantly from low income families (Harpin et al., 2016; Black & Fernando, 2013). Harpin et al. (2016) explored the effects of a 10-week mindfulness program for a group of fourth grade students. In addition to considering specific indicators in the pre-intervention and post-intervention (e.g., prosocial classroom behaviors, emotional regulation, academic competence), researchers also gathered qualitative data surrounding student thoughts about the intervention. Not only did the data show statistical significance for the intervention group on every indicator of the utilized survey, but 100% of students also reported enjoying mindfulness classes, that they would use mindfulness again in the future, and they think more people should learn mindfulness.

Black and Fernando (2013) found similar results when examining the effects of a mindfulness intervention within one school for students spanning from Kindergarten to sixth grade. Researchers implemented a 5-week program and aimed to determine whether extending the intervention would provide additional benefits to student outcomes. Results indicated that the initial intervention curriculum did lead to improved behavior in a variety of areas, including attention, self-control, participation, respect.

Another form of mindfulness program used at the elementary school level involved the practice of mindful yoga in the classroom (Bazzano, Anderson, Hylton, & Gustat, 2018). Third graders with anxiety symptoms on life satisfaction (i.e., emotional and psychosocial quality of life) participated in mindful yoga to promote stress management and improve anxiety symptoms. Results showed the intervention benefitted not only students, but also the teachers and other staff by allowing teachers, as well as students, to be more calm. Another yoga-centered mindfulness intervention led by Mendelson et al. (2010) examined whether a school-based program could lower levels of stress among urban youth. Results indicated that the intervention was well-received by students, teachers, and administrators and had a positive impact on stress responses for students. Finally, Higgins and Eden (2017) led a study focused on mindful breathing in an elementary mathematics classroom. This study differed from many other mindfulness interventions in that the researchers did not search for measurable gains; rather, they examined cogenerated understandings of how mindfulness-based breathing can encourage participants to engage students in the classroom and promote productive learning environments. The researchers found that mindful breathing can lead to collective understandings in a classroom community.

Mindfulness and Secondary Education

Mindfulness in the classroom is not only impactful for young children, but studies also show positive outcomes for older students. Within secondary schools, a variety of mindful intervention have been employed. López-González, Amutio, and Herero-Fernández (2018) explored the relationship between relaxation-mindfulness, classroom climate, and academic performance in a group of 420 high school students. Results indicated that classroom climate is a mediator between mindfulness and academic performance; mindfulness does not have a direct effect on academic performance, but it does exert an influence on classroom climate, which in turn affects academic performance. Additionally, Rodríguez-Ledo, Orejudo, Cardoso, Balaguer, and Zarza-Alzugaray (2018) looked at the correlation

between emotional intelligence and mindfulness in students aged 11 to 14 years. They found a significant relationship exists between mindfulness competence and better social adjustment within a school context. Also, data suggests that mindfulness practices can act as a protective factor for mindfully attending during adolescent years.

Some secondary mindfulness interventions have focused on specific populations; one study looked at the effects of mindfulness practice on middle school students facing homelessness compared to traditional middle school students (Viafora, Mathiesen, & Unsworth, 2014). At the end of this 8-week intervention, both groups reported feeling less stressed and more relaxed, patient, concentrated, and alert. Students showed improvements in mindful awareness and acceptance and had overall positive impressions of the course; however, students facing homelessness had more favorable outcomes than the group of traditional students, including higher evaluations of the course, greater emotional wellbeing, and a higher likelihood of using mindfulness in their daily lives. A qualitative study by Wisner and Starzec (2015) tested a mindfulness skills program with students in grade 10 at an alternative school. Data analysis from this 7-month study showed students' perceived benefits to be both intrapersonal (e.g., self-awareness, self-regulation) and interpersonal (e.g., building relationships, learning to trust). Similarly, Milligan et al. (2016) implemented a mindfulness-based martial arts program with a group of high school students in grades 9-11 who were at-risk for self-regulation challenges. Findings from this intervention suggested that participants experienced decreases in cognitive errors (e.g., catastrophizing) and increases in the use of strategies such as acceptance, positive thinking, and avoiding rumination.

Mindfulness in the Classroom: Adults

As seen previously, the use of mindfulness in classrooms has shown benefits for children in early childhood populations through adolescent populations at the secondary level. However, less research has been completed at the postsecondary level. After a thorough search, we found research demonstrating the use of mindfulness in the classroom at the graduate level to be quite scarce.

Mindfulness and Postsecondary Education. Gray, Font, Unrau, and Dawson (2018) found significant decreases in stress levels and heightened sleep quality for undergraduate students who participated in a brief mindfulness-based intervention. Researchers have also found mindfulness-based interventions can significantly reduce stress, anxiety and depression in undergraduate students (Hall et al., 2018). Additionally, when a men's Division I athletic team participated in a five week mindfulness based intervention, they increased mindfulness and goal-directed behavior (Goodman, Kashdan, Mallard, & Schumann, 2014).

Adults and Graduate-level Classrooms. Mindfulness-based interventions can certainly also impact adults in several positive ways. Research has shown support for mindfulness interventions for parents and for mental health benefits for various specific populations. Specifically, researchers have found mindfulness-based cognitive therapy can help people suffering with Bipolar Disorder to be less judgmental of their own thoughts, sensations and feelings (Strange et al., 2011). Additionally, Shorey, Elmquist, Anderson, and Stuart (2015) found a negative correlation between mindfulness and aggression in women being treated for substance abuse. Lastly, lower levels of mindfulness has been correlated with higher levels of depression in new parents (Hicks, Dayton, & Victor, 2018). Thus, many needs for adult populations can be supported by mindfulness-based interventions. So, we aimed to bring this idea into the graduate-level classroom setting.

The Current Study

The current study is aimed at evaluating the impact of a short mindfulness-based activity in the graduate level classroom. A five-minute activity was implemented weekly and participants completed a pre-test and post-test to evaluate the effectiveness of the intervention. The research question is: Can a five-minute mindfulness-based activity implemented weekly help increase overall mindfulness for a group of students in a graduate-level classroom?

METHODS

Participants

Ten female first-year graduate students participated in this study. The participants were selected because they were enrolled in a course related to statistics and research methods. All participants agreed to be included in the study voluntarily.

Instruments

The Cognitive and Affective Mindfulness Scale – Revised (CAMS-R) (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007) was used as a pre-test and post-test measure. The CAMS-R is a 12 item scale, with three items representing each of 4 subcategories (attention, present focus, awareness, acceptance) (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). Acceptable internal consistency (alpha over .8) has been reported for the population in two studies with large samples (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007).

Procedure

A group of ten students was asked to participate in the study by completing a short pre-test (CAMS-R), participating in a five-minute mindfulness-based activity each week for 6 weeks, and then completing a post-test to evaluate if the activities could produce an overall increase in mindfulness for the group. Each week, one member of the group would find an activity and lead the group through the chosen activity. The weekly activities are described below. After the completion of the six weeks of activities, each participant completed the CAMS-R as a post-test.

The activities:
Week 1: The participant leading the exercise passed out cupcakes to the entire class. She asked all participants to remove their shoes and to try and place our feet on the floor. She also showed alternative ways to sit that may be more comfortable for some participants, including cross legged and half or full lotus. Participants were asked to face their cupcakes while grounding their bodies, aligning hips, shoulders and ears. Next, participants were asked to start paying attention to the sounds in the room, then to notice where tension is carried in the body naturally. Then, participants were asked to focus on the smell of the cupcake to engage another sensation. Next sensation was focused on breathing. Finally, sensation was focused on taste as participants were able to eat their cupcakes.

Week 2: Week two participants followed a guided meditation through a mindfulness application called *Headspace*. The session focused on teaching participants how to breathe, as well as noticing sounds and how the body is feeling (e.g. hands on legs, feet on the floor). The leader also introduced everyone to a children's book about mindfulness entitled I Am Peace: A Book of Mindfulness (Verde, 2017). This book brings the tenants of mindfulness to a kid-friendly level and includes a guided meditation at the end.

Week 3: Week 3 participants completed a reflection activity. The following questions were written on the board in the front of the room.
What touched me today?
Who or what inspired me today?
What made me smile today?
What's the best thing that happened today?
List things for which you are feeling grateful.
Participants were given three minutes to respond to any or all of the questions in writing or simply by thinking about how they would respond. Then, participants were allowed to share their responses with the group.

Week 4: Week four was a mindful walk outdoors, where participants focused on various senses. Participants were reminded to be cognizant of walking at a natural pace and focusing on the

movement throughout their bodies. Each minute the focus was on a different sense (sight, sound, scent, and touch). The last minute, participants were asked to incorporate all senses. These walks can be very beneficial for people with desk jobs or those who spend large quantities of time looking at computer screens; rather than checking email or social media during a break, taking a mindful walk allows for a different kind of relaxation. This exercise can also be adapted for kids in the form of taking a *safari walk* to explore flora and fauna.

Week 5: This week fruit snacks were used to give a focus to the activity. The leader of the activity read aloud a script that instructed participants to connect to breath and body. Participants were asked to notice the thoughts, emotions and sensations they were experiencing. Next, focus returned to the fruit snack and participants thought about how they were made, and hands it passed through to get to them. Next they were asked to notice the bodily feelings experienced when just looking at the fruit snack. Then they were asked to smell it and notice those reactions, then to put the fruit snack in their mouth and roll it around without biting it. Last they were instructed to slowly chew it and notice the motions and process of chewing, and finally swallowing it, noticing movement down their throats and to their stomachs.

Week 6: The final week, participants were given an activity that could benefit both children and adults. Participants blew bubbles as a method of stress reduction; first taking a deep breath and visualizing a thought or situation of which they wanted to let go. Blowing into the wand, participants imagined breathing out whatever situation or emotion needed to be released, then they watched it float away and eventually pop. The first round was narrated by the researcher, and the second round each participant listened to a recording that provided guidance.

RESULTS

In order to evaluate the overall impact on mindfulness, a dependent-samples t-test was conducted using SPSS. Results showed no significant increase in overall mindfulness for the group; however, qualitative results showed participants enjoyed the intervention. There are several possible reasons for the lack of significance in the results that will be discussed in the discussion section.

DISCUSSION

Mindfulness-based interventions can be successfully used in the classroom at all ages. Flook et al. (2015) showed implementing a mindfulness-based curriculum in preschool classrooms could increase social competence, learning, social-emotional development, and health. Third grade students showed lessened anxiety and better stress management after participating in mindful yoga in the classroom (Bazzano et al., 2018). High school students have shown decreases in cognitive errors (e.g., catastrophizing) and increases in the use of strategies such as acceptance, positive thinking, and avoiding rumination following a mindfulness-based intervention (Milligan et al., 2016). Finally, mindfulness-based interventions can significantly reduce stress, anxiety and depression in undergraduate students (Hall et al., 2018).

While the aforementioned evidence shows that mindfulness can support social, emotional, and physical well-being across the ages, we struggled to find research demonstrating the use of such interventions in the graduate-level classroom. The current study employed a brief mindfulness-based activity in the graduate-level classroom on a weekly basis for 6 weeks to see if the activities could increase overall mindfulness for the group. The research question was can a five-minute mindfulness-based activity implemented weekly help increase overall mindfulness for a group of students in a graduate-level classroom? While no significant increase in overall mindfulness was shown in the group, qualitative analysis showed the participants enjoyed the activities.

There are several limitations to this study that could have impeded our ability to find significant results. First, timing for the post-test was approaching finals for the semester, so participants being

graduate students could have simply been more stressed sue to external factors. Second, our group was small with only ten participants, future studies could employ these interventions with a larger population. Next, we only met once a week and completed a five-minute activity. Future studies could require daily participation in the activities or possibly use a longer activity. Lastly, we allowed participants to choose the activities for the week, which while we believe increase buy-in, could have lowered the empirical nature of the activities. In future studies, the researcher could choose short activities that have a clear research base.

While we did have limitations, we believe this study does still contribute in important ways to the field of education. Specifically, it is one of the first studies employing mindfulness-based activities in a graduate-level classroom. We know graduate school, while exciting, can be very stressful, so instilling more mindfulness in graduate students could better overall well-being. Additionally, from a systems perspective, graduate students as adults interact in several settings beyond the classroom, with family, coworkers, neighbors, and colleagues. Therefore, benefits of learning new mindfulness strategies could support better overall interactions beyond the classroom setting.

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MACROMEDIA FLASH BASED ON GUIDED INQUIRY IN CRITICAL THINKING SKILLS AS LEARNING INNOVATIONS

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Abstract
The aim of this research was to examine the effect of students' critical thinking skills using a guided inquiry model with macromedia flash and direct instruction in chemistry learning. The researchers used a quasi-experiment, with post-test only control group design. This research was conducted at SMAN 3 Kota Ternate. The research subjects were 50 experimental group students and 46 control group students. The data were collected through critical thinking test with seven description questions to see the student's critical thinking skills that have been implemented. Then, the data were analyzed using ANOVA test statistics. The results of media validation were categorized into good and feasible, obtained from the validation test by media experts and material experts. The analysis of critical thinking skills test revealed that there is an increase in students' critical thinking skills using a guided inquiry model with macromedia flash.

Keywords: Chemical learning, critical thinking, guided inquiry,macromedia flash.

INTRODUCTION

Students consider chemistry learning as a challenging material, because it seems difficult to construct abstract concepts (Ayas & Demirbas, 1997; Nakleh, 1992). One of the chemistry materials which is hard to learn for eleventh grade of high school students is chemical equilibrium (Indriani, 2017). Most schools emphasize low-level thinking skills in learning (Bassham, Irwin, Nardone, & Wallace, 2008), whereas the students need a high-level of ability to understand chemistry that can help students solve the problems existed in daily life. As stated in Basic Competence of the 2013 Curriculum, the students are expected to demonstrate the attitude of logical, critical, analytical, consistent and thorough, responsible, responsive, and not easily giving up in solving problems. Therefore, the critical thinking skills in chemistry learning is one of the competencies that the students must possess.

Several previous studies regarding critical thinking skills were examined by Svecova, et al. (2013) and Chukwuyenum (2013) which emphasized the learning process to implement and sharpen the critical thinking skills. Duron's study (2006) also suggested that the learning process need to emphasize students' critical thinking skills which aim to produce valuable and more enjoyable learning experiences. The importance of critical thinking skills based on the above data from the previous studies is no longer be denied, because based on the results of the survey conducted by PISA (Programme for International Students Assessment), Indonesia is still far below the international average. Indonesia ranks the third from the bottom in the science performance if viewed from the average score obtained in the division of men and women (OECD, 2016). The low level of the students' critical thinking skills is influenced by two factors. First, the curriculum is mostly designed with broad material targets so that the teacher is more focused on the material completion. In other words, the students are only able to complete the calculation but are not able to connect the concept to the actual situation so that it impacts on students' learning outcomes. Second, the teachers still carry out the conventional learning as the learning activities in the classroom in which the teaching is

based on changes in practice and the result of the teacher's instructional concepts is not maximal. As a result, the students passively listen and copy in which the teacher asks and the students answer occasionally (Barak, 2007; Priyadi, 2018). A solution to overcome the low-level of critical thinking skills is by implementing a guided inquiry learning model (Bamiro, 2015). Through the use of guided inquiry learning model, the teachers can provide the opportunities for students to learn, think critically, and discuss with peers (Ibe, 2013).

In addition to the learning model, another aspect related to overcoming the students' low critical thinking skills is facilities and media used by the teacher in the learning process. Information and communication became the most important components of modern education. Information and communication education are cared all over the world and almost all educational organizations had information and communication departments (Cereci, 2019). As the information and technology field has rapid development, the information and technology use in the education field can support the learning process, and one of which is the use of macromedia flash. The presentation of the macromedia flash is easy to understand because it is able to visualize simulations and animations that make the images look real objects. Thus, using animation can affect students' thinking process (Tasker & Dalton, 2006).

Relevant previous study was conducted by Purwati and Dwisuyanti (2009) regarding the effect of guided inquiry learning methods and the learning media used in their study was macromedia flash which is categorized into audio-visual media. It was implemented in learning solubility and solubility product constant (Ksp) material to improve the student's learning outcomes. To be summarized, the students' learning outcomes taught with guided inquiry learning method using macromedia flash media are higher than conventional methods. Besides, the cognitive aspects developed with the implementation of guided inquiry learning method using macromedia flash media are C2, C3 and C4. The levels of cognitive aspects are C2 (Understanding), C3 (Application) and C4 (Analysis). The average normalized gain are C2, C3 and C4.

Based on the explanation, the recent research aims to examine the effect of the guided inquiry learning model using macromedia flash and direct instruction models on the students' critical thinking skills (C4, C5, and C6) in the material concept of chemical equilibrium at Ternate State High School 3 (SMAN 3 Kota Ternate).

METHODS

This research examines the effect of independent variables (guided inquiry using macromedia flash) and dependent variables (critical thinking).

Research Design

The design of this research is a quasi-experimental design, namely post-test only control group design. The research design is shown in Table 1.

Table 1: Post-test only control group design

No	Class	Treatment	Post-test
1	Experiment	X_1	**O_1**
2	Control	X_2	**O_2**

Note: X_1 is the learning with a guided inquiry model using macromedia flash, X_2 is the learning with direct instruction model, O_1 is the posttest experiment, and O_2 the is posttest control.

Subject

The students of XI IPA class (eleventh grade of science) at SMAN 3 Kota Ternate were the subjects of this research for a month, with 50 students in the experimental class and 46 students in the control class. The sampling technique used was cluster random sampling.

Instrument

The instrument of this research was a test. The test is conducted to see students' critical thinking skills. Before the instrument is used, the validity tests (material and media) and reliability were conducted.

Data Analysis

The data were analyzed through ANOVA test using SPSS version 19 (a software package used for statistical analysis).

FINDINGS

This study examines the effect of independent variables (guided inquiry based macromedia flash) and dependent variables (critical thinking). A guided inquiry-based macromedia flash and materials packaged in the form of interactive multimedia-based computer software. In this macromedia flash, there are three chemical equilibrium factors, namely the effects of concentration, pressure and volume on the shift in equilibrium direction and temperature. In the maromedia flash, there is a syntax of guided inquiry learning models. The syntax of the guided inquiry learning applied in the media models were adapted from the synthesis steps according to Orlich *et al* (2010); National Research Council (2000); Martin (2002); Wang and Posey (2011). The result of the synthesis of the guided inquiry phase in the media is that students write on student worksheets to formulate problems, write hypotheses from questions that have been made, collect data, test hypotheses, make temporary conclusions, replicate and give conclusions. Guided inquiry based macromedia flash can be seen in Appendix.

In general, the media validation category according to the ideal assessment criteria (Azwar, 2015) described in the Table 2.

Table 2: Quality of Validation Media

No	Score Range (i)	Quality
1	$\bar{X} > M_i + 1.5\ SBi$	Excellent
2	$M_i + 0.5\ SB_i < \bar{X} \leq M_i + 1.5\ SBi$	Good
3	$M_i - 0.5\ SB_i < \bar{X} \leq M_i + 0.5\ SBi$	Fair
4	$M_i - 0.5\ SB_i < \bar{X} \leq M_i - 0.5\ SBi$	Poor
5	$\leq M_i - 1\ \bar{X}\ .5\ Sbi$	Very Poor

Note: = average score; Mi =½ (ideal max score + ideal min score); SBi = x (ideal max score + ideal min score).

Based on the responses of validity test by material experts and media experts on the learning using macromedia flash with guided inquiry learning model can be seen in Table 3.

Table 3: Media Validation by Experts

No	Aspects	Average	Category
1	Learning	3.8	Good
2	Material	3.6	Good
3	Audio visual	3.4	Good
4	Software engineering	4.5	Very Good
5	**Average of all aspects**	3.84	Good

The validity assessed by the experts consists of material experts and media experts. The material experts assessed the learning aspects and material aspects, while media experts assessed audio visual and software engineering aspects. The average quality of the media in all aspects is 3.84, indicating that the media is categorized to good and it is feasible to use.

This design of flash media was adapted to a guided inquiry learning. In this research, the media was created and developed as the supporting media that can assist the teachers and students in the learning process. The design of flash media consists of cover pages, main menus, standard competencies, basic competencies, materials, and experimental simulations.

Validity and reliability

The students conducted validity and reliability tests to ensure that the critical thinking questions are valid and can be used. There are seven questions in the test. Based on the theory, if $r_{pbls} \geq t_{table}$ the question is valid, and if $\alpha \geq 0.70$ the critical thinking test can be used. Based on the results of the analysis, since $r_{11} = 0.789$, all the questions were valid and were able to use to measure the students' critical thinking skills in the SMAN 3 Kota Ternate.

Normality

The normality test was used to test the distribution of each variable data. The normality test was carried out through the Kolmogorov-Smirnov test in Table 4.

Table 4: Summary of Normality Test Results

No	Variabel	Model	Level of significance count	α = 5%	Information
1		Eksperiment	0.062	Sig> 0.05	Normal
2	Critical thinking	Control	0.060	Sig> 0.05	Normal

Based on the table above, it can be seen that the significance is more than 0.05. Therefore, the sample comes from a normally distributed population.

Homogeneity

The homogeneity test was used to test whether the sample comes from a population that has the same variance. Homogeneity test was carried out through the Levene test in Table 5.

Table 5: Summary of Homogeneity Test Results

Variabel	Level of significance count	α = 5%	Information
Critical thinking	0.884	Sig> 0.05	Homogeneous

Table 5 showed that the significance is more than 0.05. It can be concluded that the samples from both populations have the same variance.

ANOVA Test

ANOVA test was used to determine the significance of the mean difference (μ) between groups of one sample to another. These results can be seen in Table 6.

Table 6: Summary of ANOVA Test Result

Variabel	Result	Sig <0.05	Decision	Information
Critical thinking	Between groups	0.027	H_0 is rejected	There is a significant difference

Students' critical thinking scores were calculated through ANOVA test using SPSS 19 with a significance level of 5%. Based on the results of the analysis of the scores of the two classes, the significance of the two classes is 0.027, which means that the guided inquiry model using macromedia flash effectively influences the students' critical thinking skills, and it can be seen from the significant differences between the experimental group and the control group.

DISCUSSION AND CONCLUSION

The purpose of this study was to examine the effect of guided inquiry learning using macromedia flash on students' critical thinking skills. The descriptive findings from this research revealed that students' critical thinking skills in the experimental group and the control group had significant differences. In other words, there was the improvement of the students' critical thinking skills in the experimental group in that the students experienced the guided inquiry learning using macromedia flash. The results of this research also showed that there were differences in posttest mean scores of students' critical thinking skills in the control group. However, the teaching in the control group may not affect the students' critical thinking skills.

The results of this research revealed that there were significant differences between the experimental and control groups on the students' critical thinking skills at the end of the implementation of a guided inquiry learning using macromedia flash. The macromedia flash-based guided inquiry learning more effectively influences the students' critical thinking skills in the experimental group than in the control group where the teaching did not implement a guided inquiry. The results of this research are consistent with the previous research by Leo and Neo (2014), Nasution (2015), Kristanto and Susilo (2015) demonstrating that there is an effect of critical thinking skills in guided inquiry learning using macromedia flash. More importantly, the role of media, especially macromedia flash, is an important component in the learning because it provides the students with other alternative tools in order to have more choices when learning. For instance, the research conducted by Desharnais and Limson (2007) declared that media-based inquiry learning provides an interesting and open learning experience that strengthen the critical thinking skills.

The results of this study also indicated that the students' critical thinking skills has an influence after implementing the guided inquiry learning using macromedia flash in which the stages in the learning can help the students develop their scientific concepts so that they can improve their critical thinking skills. In general, the critical thinking includes cognitive skills and is based on the process of making decisions, building new knowledge and understanding (Cotrell, 2005; Palasan, 2018; Spronken-Smith & Walker, 2010). Besides, critical thinking is complex and multidimensional which includes cognitive and metacognitive skills, assessment aimed at self-regulation that results in the interpretation, analysis, evaluation, and inference (Fisher, 2009; Johnson, 2010). When experiencing the guided inquiry learning using macromedia flash, the students in the experimental group explored discovering the concepts or information such as suggesting the hypotheses, and gathering, analyzing, and interpreting the data that the students can draw some scientific conclusions. These activities are the reasons for the increase of the students' critical thinking skills in the experiment.

Based on the purpose of this research and the analysis of the research data, it can be concluded that there are differences between the students' critical thinking skills using macromedia flash-based guided inquiry learning models and direct instruction model. Therefore, the students can find the concepts and the self-regulation that are able to influence their critical thinking skills.

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APPENDIX

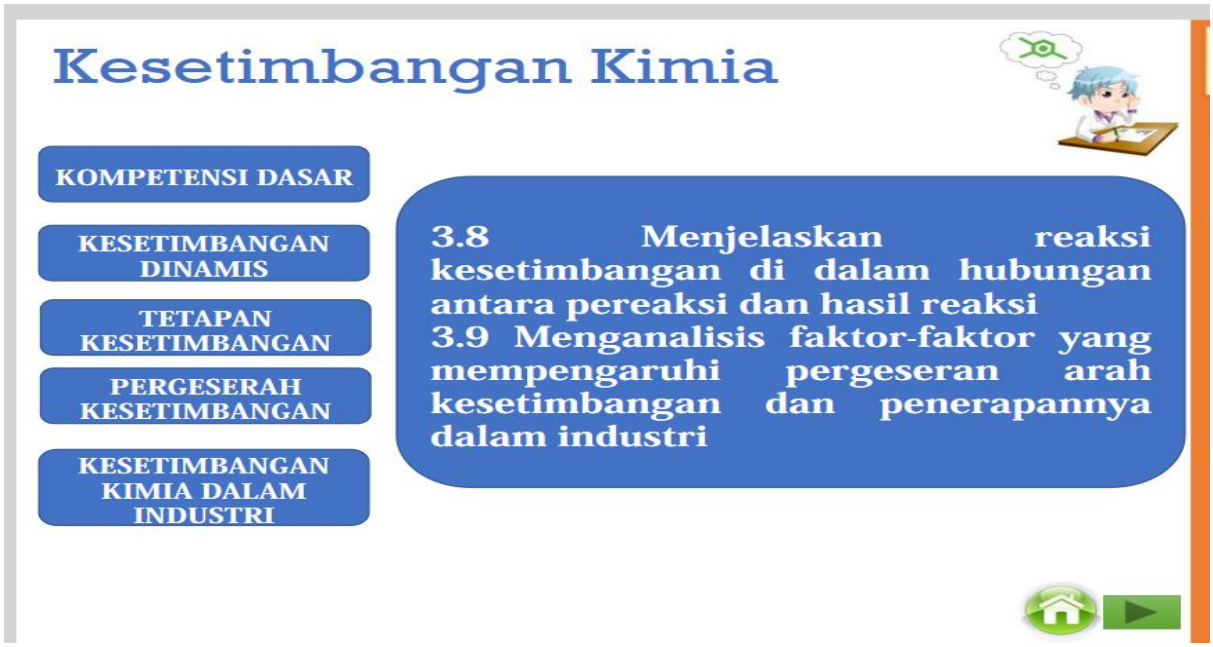

Figure 1: Menu for basic competencies

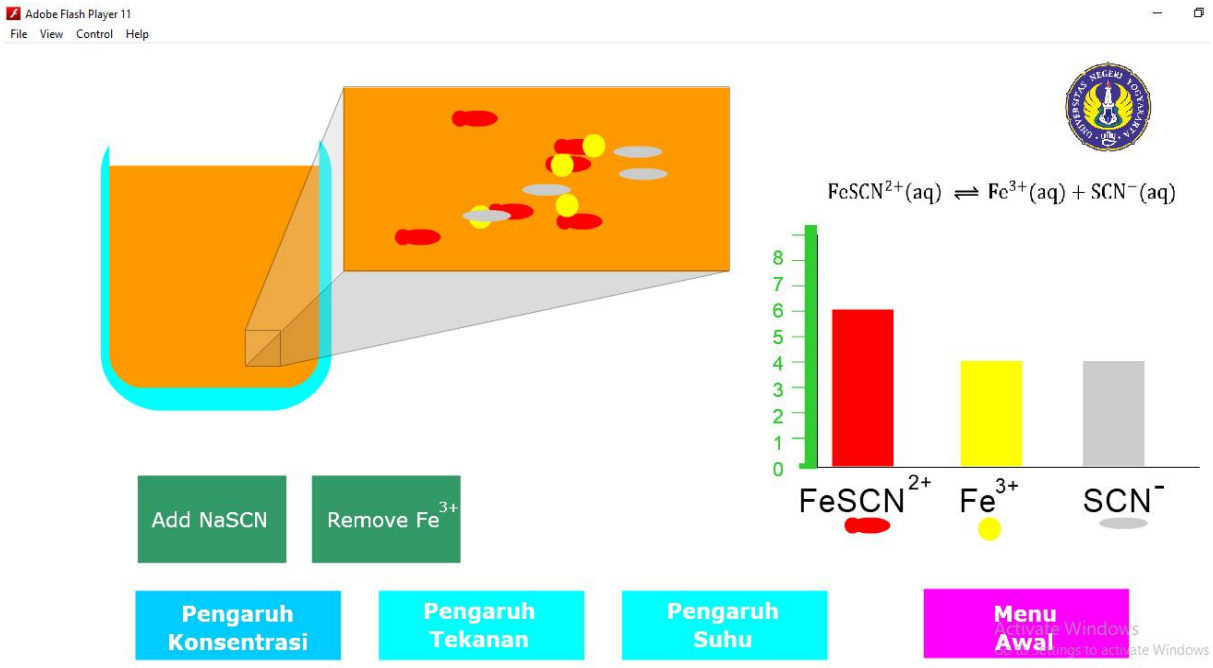

Figure 2: The effects of concentration

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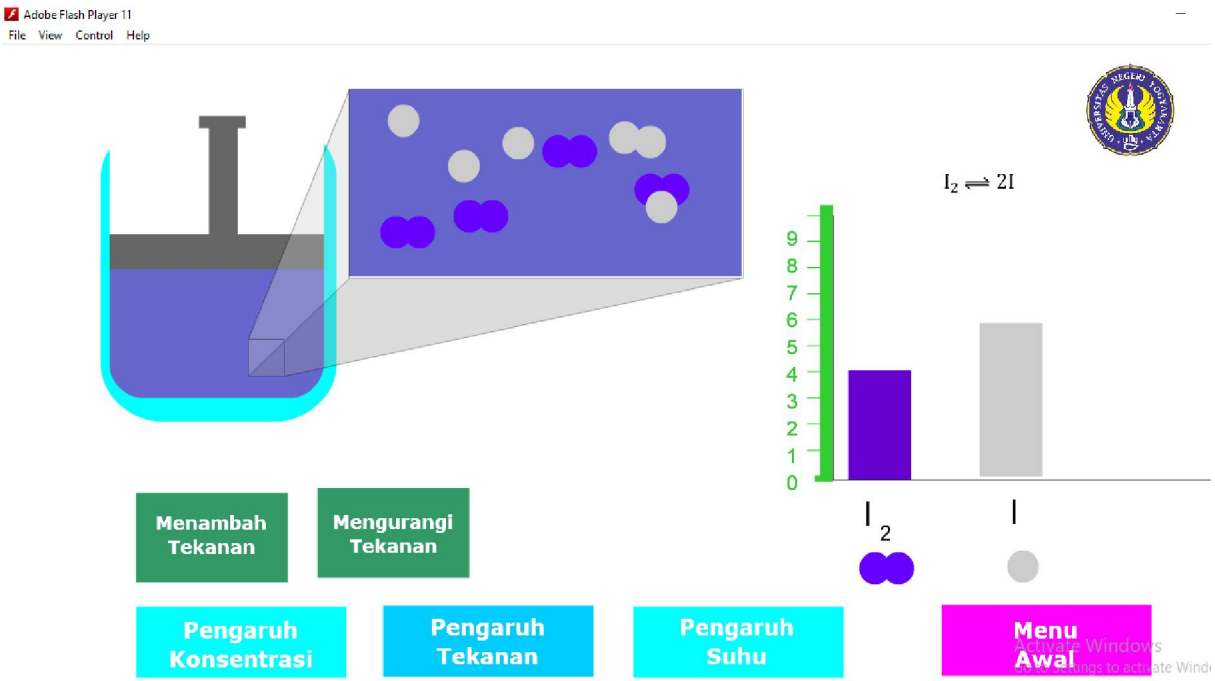

Figure 3: The influence of pressure and volume

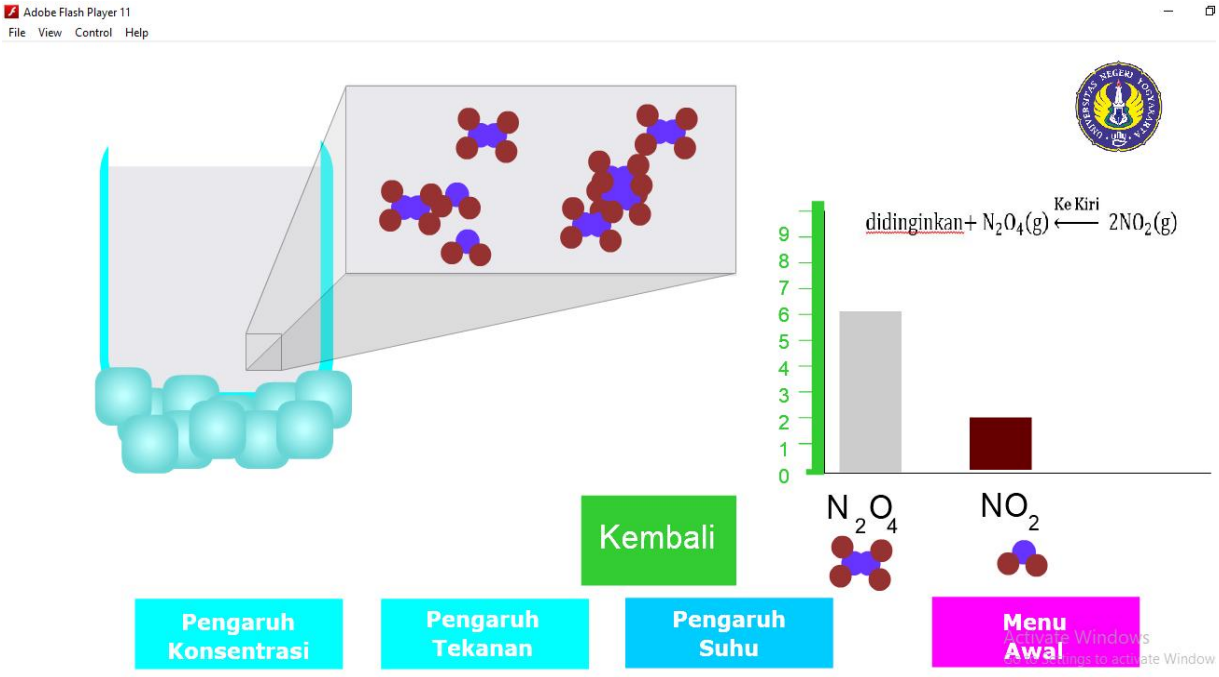

Figure 4: The influence of temperature

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SCHOOL SUBJECT COMPETITIONS AS AN EDUCATIONAL FORM

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Abstract
This article presents a study of school subject competitions, which are defined as special events where students in primary or upper secondary school have the opportunity to compete against peers in school subjects. The article analyse and discuss characteristics of this educational form across a variety of prominent competitions with a view to identifying types of competitions, and establish how their educational programmes are structured as regards educational themes and didactics. The methodological approach is divided into three phases: 1) a systematic mapping of prominent competitions, 2) a description and synthesis of the educational programmes of the competitions and 3) an analysis and discussion of the data. Systems theory, as presented by Niklas Luhmann, is applied to provide a theoretical framework with regard to the concepts of educational form, didactics, learning, contingency and structural coupling. The findings indicate that the competitions dominantly operate within the three following educational themes: 1) providing an alternative form of teaching subject matter and skills, 2) developing 21st century skills and 3) enhancing excellent students' learning. The characteristics of the three themes and their didactic approaches are elaborated along with a discussion of the potentials and limitations of school subject competitions as an educational form.

Keywords: School, subject competition, teaching, didactics, systems theory**.**

INTRODUCTION

In the early 1970s, German sociologist Niklas Luhmann started using the term *Die Weltgesellschaft – The World Society* (Luhmann, 1971), thereby acknowledging the polycentric and polycontextural society that has evolved over time. A society with a high level of complexity and higher structural contingencies, more unexpected and unpredictable changes and more interlinked dependencies and interdependencies. As he states:
[W]hen we want to observe the evolution of society there is no other choice than to focus on the social system of the world society. (Luhmann, 1997).

Luhmann's conception of the world society and its conditions is very similar to current conceptions of globalisation, and since his passing, the globalised world society has evolved further. With regard to education, the consequences of globalisation have been a much-debated topic. In this context, there is a common understanding among a large number of educational researchers and policy makers that the developed countries cannot compete with the developing countries on salary or productions costs. Therefore, the developed countries must survive the international competition caused by globalisation by excelling in relation to other parameters (Naidoo, 2018; Antunes, 2006; Campbell and Pedersen, 2014). This common understanding of globalisation, and its circumstances, has led to the catchphrase that *workers must work smarter, not harder*, thereby indicating the need for a higher level of knowledge, skills and competencies among the population (Sweetman, 2002; Potocan and Mulej, 2009). In continuation hereof, these circumstances have led to some major changes in educational systems throughout the last decades (Brown et al., 2008; Mundy et al., 2016; Ramirez et al., 2016; Sjøberg, 2015). Luhmann did not write much about the interrelation of changes in educational systems and the world society. However, he developed an extensive theoretical programme for analysing this theme, which will be applied in this article. But firstly, I will focus on the part of the theme that is of interest to me, which is the emergence of school subject competitions.

One common denominator for the aforementioned interrelation of the world society and educational systems is that new educational forms are moulded into shape in the educational practice of schools

(Sivesind and Wahlström, 2016; Ottesen et al., 2013; Amos et al., 2002). I will argue that one example of such new educational forms is the emergence of school subject competitions. Research within this field has indicated that some school subject competitions have the potential of enhancing students' motivation for the subject, thereby increasing their performance (Liu and Young, 2017; Cotton et al., 2013). Some competitions have proven to be an attractive way of binding up technology and education (Dagiene, 2006; Eguchi, 2016). Subject competitions are known for their ability to enhance skills and knowledge, ensuring that students achieve their learning goals (Huang et al., 2016; Florian, 2014; Christensen and Wistoft, 2016). In summary, I will argue that research within school subject competitions in general has been concentrated on measuring the outcomes for participating students – and research papers in this field typically focus on individual competitions. However, little attention has been given to analysing and discussing the general characteristics of this educational form across competitions. Therefore, I will address the following research question:

- Which forms of school subject competitions have emerged, and how are their educational programmes structured with regard to educational themes and didactics?

METHOD

With the aim of answering the research question, I will a) map prominent school subject competitions, b) describe and synthesise the educational programmes of the mapped competitions and c) analyse and discuss the empirical data of the mapping. In this methodological section, I will describe the process of the three phases and the approaches I have chosen.

I define a school subject competition as a special event where students in primary or upper secondary school have the opportunity to compete against peers in school subjects. With a view to mapping prominent examples thereof, I have performed internet searches with the search terms *school, education, subject, competition, contest* and *championship*. This resulted in a huge number of results, which I have assessed based on the following inclusion criteria to determine whether to include the search results in my analysis:

- The search results must meet the above definition of a school subject competition
- There must be an explicit programme with a self-description of:
  - The concept (What is the basic structure of the competition?)
  - Didactic reflections (What are the intended student outcomes? And what approach does the competition apply to ensure that students achieve these outcomes?)
  - Judging criteria (What is expected from the students?)
- The programme must be written in English or one of the Scandinavian languages

I have systematically excluded all search results that do not meet the above list of inclusion criteria. From the search results that do meet the criteria, I downloaded the educational programme of each competition and uploaded it to the software platform Nvivo, which is a software for coding and analysing qualitative data (Bazeley and Jackson, 2014). This process resulted in the inclusion of 50 school subject competitions as cases in this study. In Nvivo, I coded all the educational programmes by the name of the competition, country of origin, geographical range (local, regional, national or international), school subjects of interest, targeted age group, competition concept, didactic reflections and judging criteria. By extracting my coding and synthesising the content, I constructed the table in appendix 1, which serves to illustrate and make it transparent which competitions are included.

For the analysis of the empirical data, I will start by presenting a descriptive analysis of the four quantifiable coding points, which are: 1) the geographical origin of the competitions, 2) the geographical range of the competitions, 3) the school subjects that are integrated in the competitions and 4) the age levels that the mapped competitions are aimed at. After the descriptive analysis, I will present a semantic analysis. Luhmann defines semantics as certain structures that *hold ready forms of meaning that communication treats as worth preserving* (Luhmann, 2000). To study semantics means to study how a pool of generalised forms are created, and how they create a horizon of meaning that can be used in communication to manage expectations (Luhmann, 1993; Åkerstrøm,

2003). This means that I intend to examine the semantic structures that emerge when I observe the self-descriptions of the mapped subject competitions. Part of this process is to identify the educational themes and what characterises them with regard to didactic approaches.

The concept of *educational form* is central in this study. I rely on Luhmann's systems theoretical concept of *form*, which is inspired by George Spencer Brown and his book *Laws of form* (Brown, 1969). The essence is that distinctions constitute forms by indicating something in this world and thereby distinguishing the indicated something from the rest of the world. The concept of educational form is therefore understood as the distinction based on which education is shaped. When education is carried out in the form of subject competitions, it relies on various distinctions that indicate exactly why a certain approach is selected, and why it has its special characteristics. An essential part of systems theory, as an semantic analytical approach, is to observe such distinctions, and to analyse on what basis they are drawn.

Descriptive analysis

As can be seen in figure 1, there is a majority of American cases among the mapped school subject competitions, and Scandinavia is also well represented considering the small size of these countries. But this comes as no surprise as the searches were performed in English and the Scandinavian languages. European countries such as Germany or France have no reason to write educational programmes of subject competitions in English, unless they have an international range. The reason for the geographical skewness could also be that subject competitions are more widespread in the USA. However, this study does not claim to be exhaustive in the form of mapping all subject competitions in the world. It is the result of the search strategy that was outlined in the methodology section. Nevertheless, it should be noted that countries all over the world are represented, which indicates that this is not just an American or Scandinavian educational phenomenon, and that the topic is globally relevant.

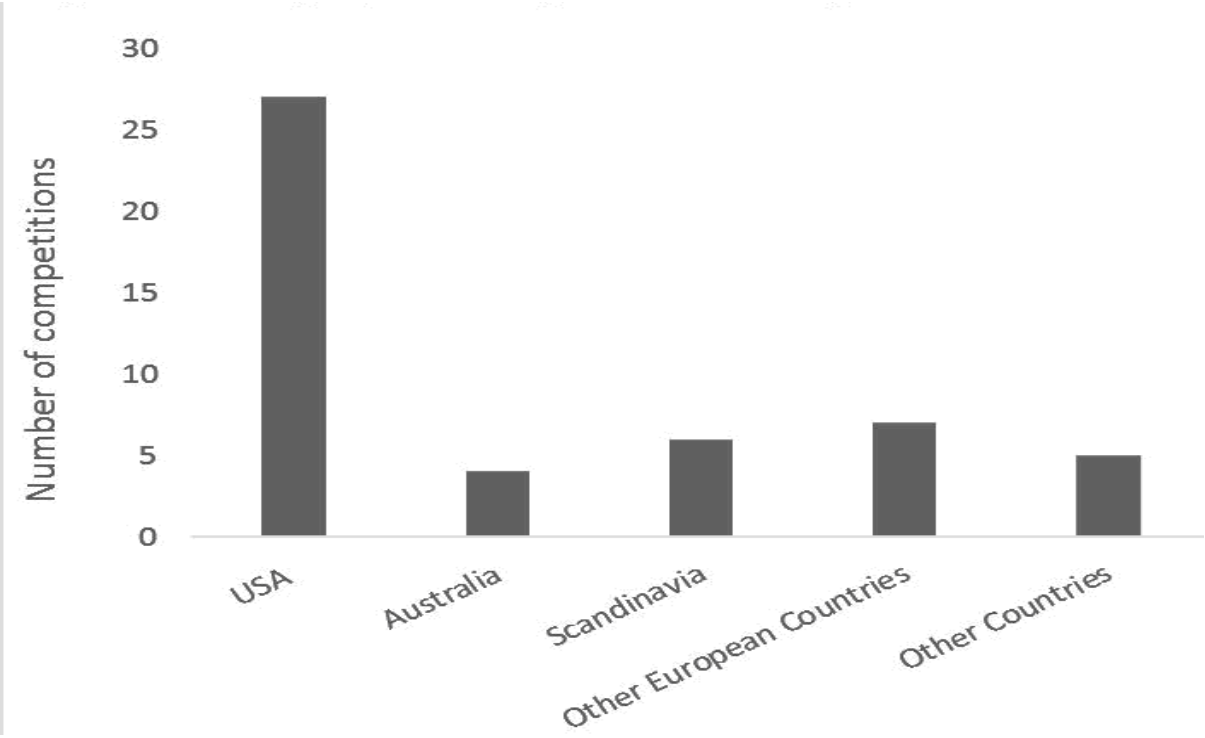

Figure 1: Geographical origin of the competitions

Figure 2 illustrates that 35 of the 50 mapped competitions operate on a national level, while 15 have an international reach. The reader should be aware that all of the competitions have a local or

regional aspect. For example, many of the competitions provide teaching sessions at local schools before the students are encouraged to participate in a regional championship. From here, they can qualify for the national or international part of the competition.

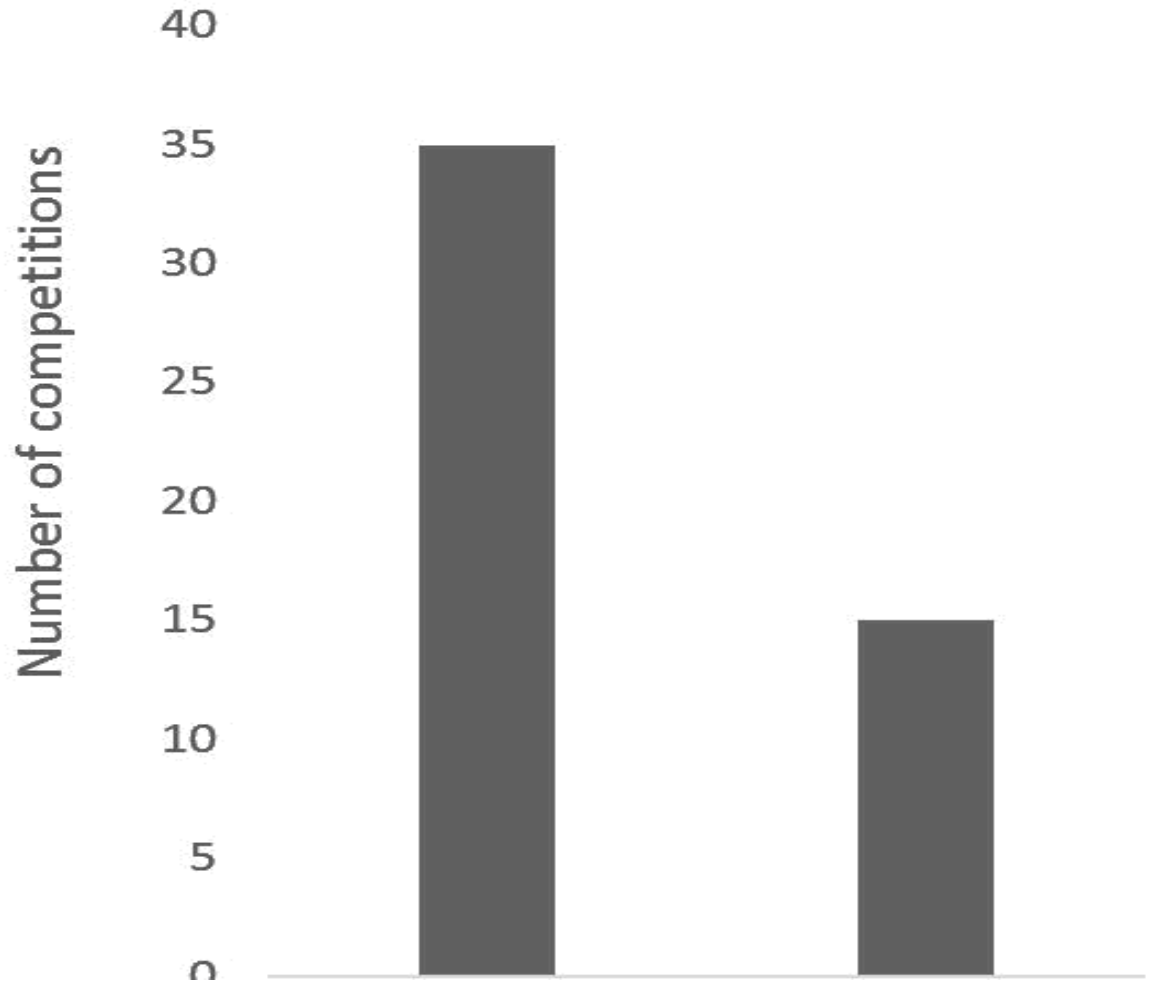

Figure 2: Geographical range

Figure 3 illustrates that the competitions are centred on many subjects. Note that the total number of competitions exceeds 50. This is because many of the competitions include more than one subject. For example, the majority of competitions are centred on STEM-related subjects (Science, Technology, Engineering and Math), often by combining different aspects of STEM subjects to develop innovative student products. Also note that art is well represented, often in the form of competitions where students must be artistically creative. Three of the competitions explicitly claim to include all school subjects. This is typically carried out as an interdisciplinary project where students must use the different subjects to improve their project and come up with different perspectives on the theme that they are working with.

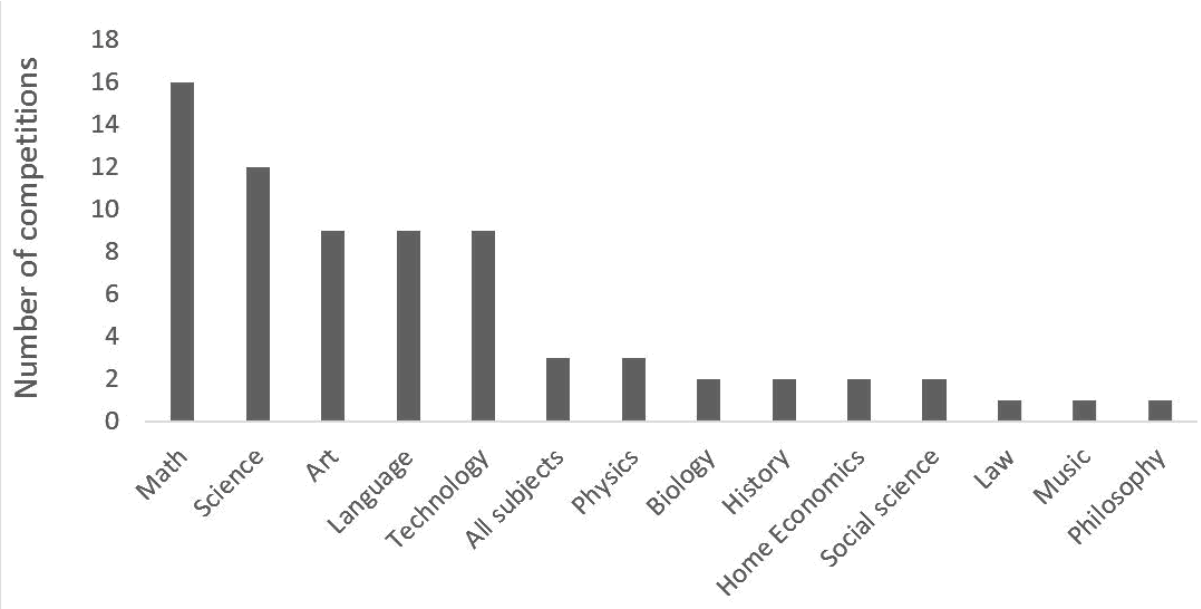

Figure 3: School subjects ıntegrated in the competitions

Figure 4 illustrates that the age of the participants in the mapped competitions ranges from 6 to 19. Again, the total number of competitions exceeds 50 because most of them allow participation by students from more than one age group. Many competitions also divide the students into different age categories, so that they only compete with peers of approximately the same age. I would like to point out that the most prominent age group is 14 years and the age levels nearby. This is partly a result of the search strategy and the inclusion criteria, which stated that the subject competitions should be aimed at students in primary or upper secondary school. However, I also interpret it as an indication of the age levels for which this educational form is considered suitable within primary and upper secondary school.

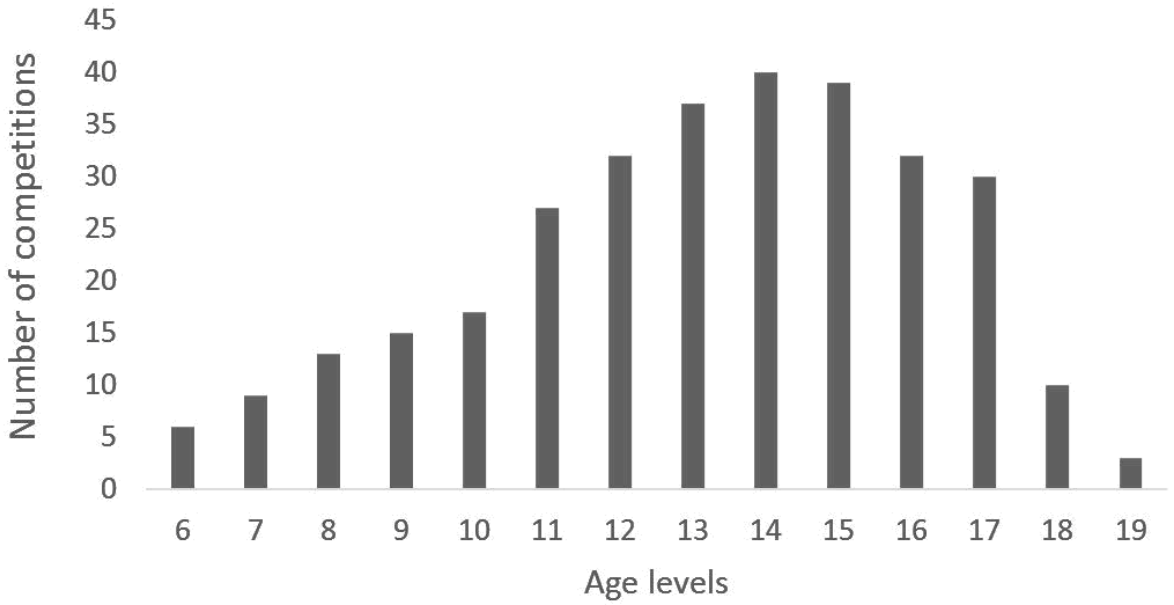

Figure 4: Age levels that competitions are aimed at

Semantic analysis

Part of my analytical strategy is to exploratively read all the programmes of the mapped subject competitions and, in this process, to code all text addressing the coding points that I outlined in the

methodology section. By extracting the coding points, it is clear that subject competitions operate with a broad variety of educational themes and didactic approaches. However, some themes and didactic approaches are more dominant across the self-descriptions in the educational programmes than others. Through this analytical process, I found that the three most dominant educational themes in the mapped school subject competitions are: 1) providing an alternative form of teaching subject matter and skills, 2) developing 21st century skills and 3) enhancing excellent students' learning. In the following sections, I will elaborate and discuss the characteristics of these themes along with the related didactic approaches.

FINDINGS

Most of the competitions that I have analysed are not merely school subject competitions in the form of competitive activities. They also provide specially developed teaching sessions that are meant to be carried out before and after the activities where the students actually meet to compete. The overall intention of these teaching sessions is to facilitate learning processes for the participating students. Before going further into how these teaching sessions are described, I will provide a definition of teaching and learning.

From a Luhmannian perspective, teaching is defined as communication that intends student learning. From the same theoretical perspective, learning is defined as an operation where students expand their consciousness (Luhmann, 1988). Hence, the system reference of teaching is social, and the system reference of learning is psychic. An important point in this context is that social and psychic systems are both regarded as closed systems, which means that a direct transfer of knowledge from one system to the other is not possible. Teaching can still result in learning, but it must be worthy of structural coupling. Students must experience the teaching as meaningful if they are to connect themselves hereto – if they are to participate on a level that exceeds just being physically present. Within educational research, it is therefore relevant to observe the communication that emerges from the self-descriptions of this form of teaching to answer the questions of what learning outcome is intended, and what didactical reflexions are made in this context to ensure that the teaching becomes worthy of structural coupling.

In the light of the above theoretical framework, subject competitions and their teaching sessions can be interpreted as a form of communication that intends to expand the consciousness of the participating students. In all the cases analysed in this study, the learning intentions are related to specific subject matter and skills. This is obvious when considering that one of the inclusion criteria for this study was that the competitions should provide students with the opportunity to compete against peers in school subjects. The learning intentions are therefore also coupled with the subject matter and skills related to each competition. However, I find it interesting that in the educational programmes, the teaching sessions of the school subject competitions are often described as an alternative form of teaching subject matter and skills. It is repeatedly emphasised that this form of teaching differs from more traditional and hegemonic ways of teaching in schools. Hence, the educational programmes distinguish between traditional teaching and the teaching of school subject competitions. The descriptions of "traditional teaching" in the programmes are often vague, and in my interpretation, the meaning of this term is considered self-evident. In the few explicit definitions that exist, traditional teaching primarily involves students sitting at their desks listening to the teacher or following instructions. None of them claim that all traditional teaching is like this, but they nonetheless maintain that such teaching practices are very dominant. Therefore, most of the mapped competitions emphasise that participating students will attain a higher level of subject knowledge and skills, which is explicitly put forward as an argument for why the students and teachers should participate in the competition – as a way of legitimising the competition as part of the educational system. This raises the question of which didactic approach the competitions adopt to distinguish this educational form from traditional teaching. I will address this question in the following section.

Developing 21st century skills

As I argued in the introduction, many single case studies indicate, that school subject competitions have the potential to realise subject-related learning intentions for participating students. But I will argue that an essential characteristic of the mapped competitions is that students typically do not just compete to achieve core knowledge and skills related the specific school subject. There is an add-on, which is the opportunity to work independently and creatively with a high degree of collaboration to create innovative products. In continuation hereof, another common description is that school subject competitions address real-world problem-solving tasks, which these two quotes illustrate: *It's as close to real-world engineering as a student can get.* And: *The competition involves students producing games and apps that offer solutions to real-world problems.* The proclaimed coupling with real-world problem solving is that it makes the teaching less abstract, and it provides a more meaningful learning process. It is claimed that students are more motivated to participate in the teaching and tend to be more engaged when they can relate what they are doing to something in the real world. In this context, many different terms are used across the self-descriptions of the competitions, but I will argue that they can be comprised and described as 21st century skills. This term has been defined in numerous ways. However, it commonly consists of skills and abilities that are considered necessary for students to succeed in their later working life and in modern society (Dede, 2010; Binkley et al., 2012). Furthermore, there is a consensus that 21st century skills are constituted by an increased worldwide demand for creativity, perseverance, critical thinking and problem solving combined with the ability to perform well as part of a team (Larson and Miller, 2011; Griffin and Care, 2014). I will argue that the mapped school subject competitions in general are intended as educational practices where students work under conditions that are claimed to be very similar to the modern labour market in the developed countries, as it has evolved in the globalised world. I will also argue that this makes sense from a Luhmannian perspective, because the function of the educational system is centred on socialising individuals, thereby ensuring that they become able to function within modern society (Luhmann and Lenzen, 2002; Qvortrup, 2005; Luhmann and Schorr, 2000: 271-274). So at first glance, the interrelations of 21st century skills and school subject competitions have a sympathetic and compassionate objective, which is to prepare children and young people to meet the future. However, there appear to be private companies behind many of the competitions that I have mapped. Thus, one should also question the extent to which private companies are to shape today's education. But since this question falls out of the scope of this article, I will not address it further. I find it more relevant to examine whether the competitions and the interrelated teaching sessions favour subject matter and subject skills or 21st century skills. In the following section, I will elaborate on this question by comparing and discussing two different didactic approaches to school subject competitions.

The study presented in this article is an international comparison, which should always be carried out with care, because national educational systems differ very much in terms of cultural background as well as the values that shape the educational forms and didactic approaches. One example of a major difference is observable when comparing the Japanese bento competition and the National Danish Championship in the subject Food Education. Both are competitions within the subject Home Economics and the part of the subject that relates to food and cooking. They both have specially developed teaching sessions, which are meant to be carried out before and after the activities where the students actually meet to compete. Both competitions aim at increasing the students' knowledge and skills related to food and cooking. So I will argue that the similarities are very easy to observe. However, there are also differences which become very clear when analysing and comparing the judging criteria. The Danish competition values the level of student participation, collaboration and innovativeness, while the Japanese competition values cooking efficiency, safety, hygiene and nutritional balance. In my interpretation, this exemplifies how the Danish competition more explicitly focuses on 21st century skills, while the Japanese competition focuses on the attainment of subject knowledge and skills of Home Economics. Both competitions address elements of 21st century skills and the attainment of subject knowledge and skills in Home Economics. However, I find it interesting to analyse what is given priority, because from a Luhmannian perspective, prioritising one over the other is a contingent choice (Baraldi and Corsi, 2017). Here, contingency refers to the fact that other

choices could be made, but the final choice is not random. On the contrary, the final choice indicates what is considered valuable – what is considered most important for the students to learn. In the Danish competition, the argument is that the students attain subject-matter knowledge and skills by applying 21st century skills as an didactic approach. But what is being judged is not their level of subject-matter knowledge and skills. It is rather their ability to work independently and creatively with a high degree of collaboration to create innovative products – their attainment of 21st century skills. This is not necessarily problematic if it is actually the intention of the teaching. However, as I elaborated earlier, many of the competitions legitimise their role in the educational system by proclaiming that they enhance the subject knowledge and skills of the participating students. Hence, there are divergent learning intentions. My argument is that educators should be aware of this divergence, and the risk that the focus on 21st century skills can overshadow the attainment of subject knowledge and skills, which is the essence of the judging criteria.

Enhancing excellent students' learning

As I stated in the descriptive analysis, most of the competitions are either nationally or internationally oriented. However, they typically also have a preceding local and/or regional level wherefrom the best performing students advance in the competitions. Thus, the competitive element is fundamental in this educational form. It is repeatedly emphasised as a special opportunity for excellent students to be challenged, and as a way of facilitating learning processes where the students can perform their best. Furthermore, the intention behind the competitive element is repeatedly and explicitly described as a didactic approach aimed at recognising and cultivating the talent of the brightest young minds. A well-known issue with regard to enhancing the learning outcomes of excellent students is that teaching becomes too simple and does not challenge the students enough (Freeman, 2013; Rubenstein et al., 2012). When this occurs, it could be argued, from a Luhmannian perspective, that students experience an inappropriate level of variety and redundancy in the teaching (Luhmann and Lenzen, 2002). They simply experience too much redundancy (repetitions) and are not subjected to requirements that can challenge them enough in their learning process. In the light of the previously described focus on 21st century skills, I find it plausible that the typical didactic approach of school subject competitions can handle this educational challenge. Especially because the limits are very wide, as the students are expected to constantly develop and perfect their products. There is no definitive or presubscribed result, and the students are constantly inspired by other students who also perform at a high level. Not only at their local school, but also the most excellent students in a national and international context. However, I find it striking that very few of the self-descriptions address the influence on other groups of students than the excellent students. This can be regarded as a blind spot. There are only two examples of the opposite in the entire data material. One of these two programmes proclaims that it gives students who fear the subject of math a chance to feel successful in a math project. The other programme stresses that the competitive element can motivate even the most unenthusiastic students. However, I will argue that there is a contradiction. It is common sense that students who fear or are unenthusiastic about a specific subject do not also fall into the category of excellent students. Nonetheless, when this group of students participate in a school subject competition, they compete with the excellent students in a competition where only the best advance. In this part of the didactic approaches, it is difficult to see what elements should motivate the students that fall outside the category of being excellent.

DISCUSSION AND LIMITATIONS

In this article, I have argued that school subject competitions mainly operate with three educational themes. However, there are examples of school subject competitions which do not operate with all of the three themes that I have identified. One example hereof is an essay competition which seeks to promote the spirit of Americanism and patriotism among American youth. Accordingly, I do not claim that all competitions fall within all the three identified themes. Indeed, some school subject competitions operate with other themes and didactic approaches than the ones that I have chosen to highlight. In appendix 1, the reader can gain an impression of all the ideographic themes and didactic approaches of school subject competitions included in this study. However, what all mapped

competitions have in common is that their educational programmes are coupled with at least one of the three themes. If we return to the essay competition, it is difficult to find explicit couplings with 21st century skills in the self-description of the competition. On the contrary, it is evident that the competition favours the most excellent students, and that it aims to be an arena where they can strive for perfection.

The empirical data of this study consist of self-descriptions of 50 school subject competitions. The study could have contained more data, or perhaps the same results could have been obtained with fewer cases. The reason why the final empirical sample ended up comprising educational programmes from 50 different competitions is empirical saturation. Within qualitative research, this generally means that the data collection has reached a point where newly collected data do not lead to new answers of the research question. This indicates that the data collection does not have to continue, and the researcher can be reasonably confident that further data collection will yield similar results (Saunders et al., 2018; Faulkner and Trotter, 2017; Fusch and Ness, 2015). Concretely, in this study I collected data until I estimated that there was a sufficient minimal foundation to answer the research questions. This point was reached when the data were comprised of approximately 30 educational programmes. I continued to collect data until new cases no longer contributed new perspectives – until the data sample was saturated. With this approach, I chose to stop at 50 cases, mostly because of empirical saturation, but also due to limited time resources. In continuation hereof, it should be stressed that this analysis does not claim to be exhaustive in the form of mapping all school subject competitions in the world. This would undoubtedly be interesting, but I also consider it a utopian ideal. Nevertheless, this article analyses a sample of prominent cases, which, from my assessment, gives a valid and reliable perspective on which forms of school subject competitions that have emerged, and also on how their educational programmes generally are structured with regard to educational themes and didactics. Additional research is still needed on this topic, from single case studies of student outcomes to large-scale research designs or systematic reviews, including inquiring into the effectiveness of school subject competitions in relation to underachieving students.

CONCLUSION

Most of the analysed competitions in this study are not merely school subject competitions in the form of competitive activities. They also provide specially developed teaching sessions that are meant to be carried out before and after the activities where the students actually meet to compete. The self-descriptions of the competitions contain semantic distinctions between traditional teaching and the teaching sessions that form part of school subject competitions. Generally, it is argued that the didactic approach of school subject competitions provides a more motivating form of teaching than traditional teaching. A very dominant didactic approach hereto is that students do not just compete in relation to their achievement of the core knowledge and skills within the specific school subject. There is an add-on, which consist of the ability to work independently and creatively with a high degree of collaboration to create innovative student products that address real-world problems. In this article, the add-on is 21st century skills. A term that has been defined in a variety of ways, but commonly consist of skills and abilities that are considered necessary for students to succeed in their later working life and in modern society. The mapped school subject competitions intend to be educational practices where students work under conditions that are claimed to be very similar to the modern labour market in the developed countries, as it has evolved in the world society. The competitions and the interrelated teaching sessions differ with regard to whether they favour subject-matter knowledge and subject skills or 21st century skills. In some competitions, the didactic argument is that students attain subject-matter knowledge and skills by applying 21st century skills as a didactic approach. But this contradicts with the fact that it is not the students' level of subject knowledge and skills that is being assessed. It is rather their attainment of 21st century skills. This is not necessarily problematic if it is the intention of the teaching. However, if attainment of subject knowledge and skills is the intention, then educators should be aware of the risk that other parameters can overshadow this intention.

Most of the competitions are either nationally or internationally oriented. However, they typically also have a preceding local and/or regional level wherefrom the best performing students advance in the competitions. The competitive element is repeatedly emphasised as a special opportunity for excellent students to be challenged and as a learning process where they can perform their best. The aim is explicitly to recognise and cultivate the talent of the brightest young minds. It is concluded that the typical didactic approach of school subject competitions can be considered an educational form that can provide a balance between variety and redundancy for excellent students. Not only at their local school, but also at a national and international level. However, very few of the self-descriptions address their influence on other groups of students than the excellent students.

From the analysis presented in this article, it is concluded that the mapped school subject competitions dominantly operate within three educational themes: 1) providing an alternative form of teaching subject matter and subject skills, 2) developing 21st century skills and 3) enhancing excellent students' learning.

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Appendix 1: Mapping of prominent school subject competitions

Competition	Country of origin	Range	School subjects	Age group	Concept	Didactic reflections	Judging criteria
AAPT High School Physics Photo Contest	USA	International	Physics	14,15,16,17	This contest provides teachers and students an opportunity to learn about the physics behind natural and contrived situations	Students are creating visual and written illustrations of various physical concepts. Students submit a essay of 250 words or less describing the physics in the photo. The essay should have a title and must be written by the student	A committee of physics teachers will select the top photos (scoring approximately 40% essay and 60% photograph)
AAPT Physics Bowl	USA	National	Physics	14,15,16,17	Approximately 10,000 students take a 40-question, 45-minute timed, multiple-choice test under their school's supervision.	Motivating students by letting them to compete against one another	Correct test answers
Apparatus Competition	USA	National	Physics	14,15,16,17	Students must develop their own physical apparatus	The Apparatus Competition was established to recognize, reward, and publicize worthwhile contributions to physics teaching through demonstration and experiment. Developed to pique the interest of students, used in lecture and demonstration, or simply used to help teach physics in new or fascinating ways	Apparatus is either new in design or a modification of an existing design. Apparatus is not commercially available. The specifics of the apparatus have not been published.
Americanism Essay Contest	USA	National	Language	12,13,14,15,16, 17	An essay contest.	Seeks to promote the spirit of Americanism and patriotism among American youth through writing	The essay shall be on the yearly theme designated and writing skills
Anne Frank Essay Contest	Netherlands	National	Language	10,11,12,13	An essay contest.	The contest seeks to deepen the knowledge of its namesake and to raise awareness about the refugee crisis today through a writing project	Evidence of thoughtful research, writing skills, creativity and interpretation.
Australian and New Zealand Brain Bee Challenge	Australia	International	Biology, science	15	A competition for high school students to learn about the brain and its function. Starts with an online quiz from which the regional winners advance to the finals.	Aims at motivating young people to learn about the brain. Students are given a test of knowledge about important facts concerning intelligence, memory, emotions, sensations, movement, stress, aging, sleep, Alzheimer's disease and stroke.	Correct test answers
CANSAT	UK	National	Science electronics, programming, mathematics	14	Contest where students get the opportunity to have practical experience working on a small-scale space project.	Provides an opportunity for students to have their first practical experience of a real space project. They are responsible for all aspects: selecting the mission objectives, designing the CanSat, integrating the components, testing, preparing for launch and then analysing	To fit all major subsystems found in a satellite, into the volume and shape of a soft drink can. To provide a parachute to ensure the can survives the landing. To carry out scientific experiments and transmit in-flight data to an Earth-based computer.

						the data.	
Caribou Mathematics Competition	Canada	International	Math	8,9,10,11,12,13,14,15,16,17	There are six online math competitions held throughout the year offered for students	Aims to show students that mathematical puzzles can be fun and that competing in math contests with interactive questions can be exciting. To improve student's problem solving techniques by providing a wide variety of challenging math activities .	Correct test answers
Cisco Little Big Futures	UK	National	Science, Technology, Engineering and Math	11,12,13,14	A collection of one-hour lessons and five-hour challenges across the STEM subjects and for STEM Clubs looking at the use of the Internet of Things	Aims at introducing upcoming technologies that will be part of everyday life and give students the opportunity to be creative with their learning and explore careers.	Problem solving
Clean Tech Competition	USA	International	Science, Technology, Engineering and Math	15,16,17,18	CleanTech asks students to use STEM concepts in order to research and design a product that will deal with an environmentally related issue.	The competition is designed to foster a deeper understanding of STEM related concepts, recognize outstanding talent, and prepare the next generation of globally competitive innovators.	The ability to identify a specific issue, analyze then explain in detail, and design a solution that can mitigate the negative impacts of climate change
Congressional Art Competition	USA	National	Art	11,12,13,14,15,16,17	A visual art competition where students submit entries to their representative's office, and panels of district artists select the winning entries	Aims at recognizing and encourage artistic talent among students	Each entry must be original in concept, design, and execution
Education Perfect English Championships	Australia	International	Language	7,8,9,10,11,12,13,14,15,16,17	Teachers register and sent in class lists, where after each student will receive an individual login which they use to access Education Perfect, where they must answer questions correctly.	Aims to raise the profile of English learning at local schools, and to help cement students' understanding of concepts and subject areas.	Correct test answers
FIRST Lego League	Denmark	International	Science, Technology, Engineering and Math	6,7,8,9,10,11,12,13,14,15,16	Students design, build and program a robot using LEGO, then compete on a table-top playing field.	Students must research a real-world problem, and are challenged to develop a solution. They also must design, build and program a Lego robot. It is intended that students learn critical thinking, team-building, and presentation skills	Innovation, Impact, inclusion, teamwork and fun.
FIRST Robotics	Denmark	International	Science and technology	15,16,17	Students build robots to play a field-game against other students.	Students are challenged to raise funds, design a team "brand", hone teamwork skills, and build and program industrial-size robots to play a difficult field game. The aim is to inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership.	Innovation, Impact, inclusion, teamwork and fun.
Google Science Fair	USA	International	Science	13,14,15,16,17,18	A science and technology competition. Students share their best best idea using science, technology, engineering, and math.	Focused on problem-solving, communication, and teamwork.	Participants are rewarded for being creative, inspiring, and designing projects that will make an impact on local or global communities.
Japanese Bento Competition	Japan	National	Home Economics	13,14,15	Students compete in making the best version of a traditional Japanese Lunch box (Bento)	Aims at improving students' knowledge and skills, and ultimately improving their daily lives	Efficiency in cooking, safety, hygiene, nutritional balance, presentation.
JASNA Essay Contest	USA	International	Language	12,13,14,15	An annual student Essay Contest	Intends to foster the study and appreciation of Jane Austen's work.	Original insights and clear, correct writing
Kids' Art Contest: Sketch a School Subject	USA	National	Art	6,7,8,9,10,11,12,13,14,15,16,17	An annual art contest	Aims at offering students a fun way to explore their creative side and an opportunity to be recognized for their talents.	Creativity, interpretation, technical skill, originality

Kids Philosophy Slam	USA	International	Philosophy	7,8,9,10,11,12, 13,14,15,16,17	An annual teaching program designed to make philosophy fun and accessible to kids. Student compete by uploading electronic submissions.	Younger students may paint, draw a picture or use any combination of words and pictures to express their feelings or ideas about the topic. Older students write an essay, answering a philosophical question. Aims at giving students a voice and to inspire them to think by unlocking their intellectual and creative potential through philosophy	Creativity, originality and overall strength of the message the student is conveying. Organization, and thought development, as well as spelling and grammar.
LifeSmarts	USA	National	Family and consumer science, Home economics, technology	14,15,16,17	A consumer education program followed up by a quiz based competition	Aims at encouraging high school students to learn more about the issues faced by consumers today.	Correct quiz, test answers
MATHCOUNTS	USA	National	Math	11,12,13,14	A math competition	Seeks to enable middle school students to gain confidence in their math ability. Utilises problem solving skills and positive attitudes about math, so students embrace challenges and expand their academic and career opportunities in the future.	Speed, accuracy, problem-solving, mathematical reasoning and collaboration
Math Video Challenge	USA	National	Math	11,12,13,14	A online math video competition	Intends to blend math, creativity, art and technology and challenge students to produce a video solving a math problem in a real-world setting.	Creativity, communication, mathematical accuracy, and real world application
Mathematics Challenge for Young Australians	Australia	National	Math	8,9,10,11,12,13 ,14,15	A math competition	There are three independent stages in the contest: the Challenge Stage, the Enrichment Stage and the Australian Intermediate Mathematics Olympiad. The contest is designed to help teachers motivate, stimulate, encourage and develop mathematically interested students and to bring forth the talent and potential within	Mathematical skills
MIT INSPIRE	USA	National	Art and social sciences	12,13,14,15,16, 17,18,19	A competition that involve online submission of research projects.	One hundred Finalists will be selected from the submissions to participate in the competition's final round - a two-day event on MIT's campus in Cambridge The purpose is to give students a unique opportunity to show off their research, get feedback from experts, and have an unforgettable experience before college	original inquiry on a unique topic
MTNA Student Competitions	USA	National	Music	6,7,8,9,10,11,1 2,13,14,15,16,1 7,18	A music competition	Seeks to provide educational experiences for students and teachers and to recognize exceptionally talented young artists and their teachers in their pursuit of musical excellence.	Music skills
National Danish Championship in the subject of Food Education	Denmark	National	Home Economics, Food education	12,13,14,15	A national contest where students compete in development of dishes	Students should develop their ability to work cooperatively, with a high degree of participation , and the should develop their ability to create innovative solutions cantered around food.	Student participation, collaboration, innovativeness and product quality and taste.
National Danish subject championship	Denmark	National	Language, Math, History and Biology	13,14,15	A national contest where students will solve tasks all of which are rooted in The national curriculum, but different from what they are solving in their daily education. Students should, for example, come up with creative solutions to challenges from private companies.	The purpose of the project is to demonstrate varied and inspiring teaching methods and let students participate in academic and social communities by showing their talents in the subjects.	Skills, knowledge and creative solutions to business challenges
National Economics Challenge	USA	National	Economics, Math	16,7,8,9,10,11, 12,13,14,15,16, 17,18	an online competition	Student teams compete on their knowledge, skills, and ability to work collaboratively to progress through multiple rounds which measure comprehension and application of concepts related to a rapidly changing global economy.	based on knowledge of microeconomics, macroeconomics, International economics, and current global events. Ability to collaborate as a team

National Geographic GeoBee	USA	National	Geography	9,10,11,12,13	An academic competition within knowledge of geography	Teachers receive a teaching material from which course are carried out	Correct quiz, test answers
National High School Essay Contest	USA	National	Language	14,15,16,17	An annual essay contest	The contest intends to give high school students International topics to think and write about	Submissions are judged on the quality of analysis, quality of research, writing skills, form and style.
National High School Mock Trial Championship	USA	National	Law	16,7,8,9,10,11, 12,13,14,15,16, 17,18	Promoting an understanding and appreciation of the American judicial system through academic competitions for students	Aims at high school students achieving a greater understanding through competition and education.	scoring judged upon which team makes the best presentation
National History Day	USA	International	History	11,12,13,14,15, 16,17	A year-long education program that culminates in a national contest once a year	Students hone their expressive abilities as they present their work in one of the competition's formats: paper, exhibit, performance, documentary, or website	Historical Quality, Relation to Theme, Clarity of Presentation
National STEM Video Game Challenge	USA	National	Science, Technology , Engineering and Math	11,12,13,14,15, 16,17	Students compete in creating an original video game	Aims to encourage critical thinking, problem solving, collaboration and communication Science, Technology, Engineering and Math	The students ability to develop: Engaging gameplay, come up with an innovative, creative vision, and producing well-balanced game play
Norwegian championship in English	Norway	National	Language	16,17,18,19	Students compete within one of three disciplines; formal writing, creative writing and audio visual (short film).	Intends to stimulate increased interest in English language and culture, and allow students to tap into their knowledge and creativity English subject.	Creativity, Creative Writing. Ability to convey an idea or message through an audiovisual experience
Readers Cup	Australia	National	Language	10,11,12,13,14, 15	It is a competition where teams of four students together read a set of books, and then compete with other school or public library teams to answer quiz questions from the books.	The aim is to challenge students to read widely, work collaboratively in a team and continue developing a love of reading.	Correct quiz, test answers
RoboCup Junior	France	International	Science, Technology , Engineering and Math	12,13,14,15,16, 17,18,19	A International educational robotics competition	Aims to promote STEM content and skill learning among participating students, and to expand their skills and knowledge. Introduction to the field of robotics, a new way to develop technical abilities through hands-on experience with electronics, hardware and software, and a highly motivating opportunity to learn about teamwork while sharing technology with friends.	Cooperation, creativity problem-solving and task-achievement.
School Superhero Comic Contest	USA	International	Language, Art, Citizenship, Social Studies, Geography	8,9,10,11,12,13 ,14,15,16,17,18	A lesson plan provides a sensitive overview of the issue of violence in schools, gives space to reflect on solutions for safe learning environments and walks the class through a creative superhero story-telling activity. Students are invited to submit their superhero to a contest searching for a superhero that keeps schools safe and peaceful. The winner will work with a professional artist and storyteller to bring their ideas to life in a published comic book!	Understand how the issue of violence against children is manifested in and around the school and what impact this has. Build empathy for those affected.• Bring knowledge and empathy together in storytelling to engage others in this important issue.	Problem solving, creativity, writing
Stockholm Junior Water Prize	Sweden	International	Science	15,16,17	A competition for high school students who have conducted a water-science research project.	All projects must use a research-oriented approach, which means they must use scientifically accepted methodologies for experimentation, monitoring, and reporting, including statistical analysis.	Relevance, creativity, methodology, subject knowledge, practical skills, and report and presentation
StudentCam	USA	National	Art, language	11,12,13,14,15, 16,17	An annual national video documentary competition	Aims at encouraging students to think critically about issues that affect our communities and our nation.	Videos should evaluate how this right, characteristic or event is upheld in our society, or challenged by current events. Rights or characteristics may include aspects of democracy, opportunity, liberty, justice, equality, diversity, unity, individualism, other rights, guiding principles, or shared values.

Texaco Children's Art Competition	Ireland	National	Art	6,7,8,9,10,11,12,13,14,15,16,17	A arts competition where original drawings, paintings or prints using any media and on any subject matter are eligible for submission to the competition.	Has the goal of fostering a young love of art in children.	Originality and skills
The Black Swan Prize for Portraiture	Australia	National	Art	7,8,9,10,11,12	Students compete in making the best portrait	Aims at providing young artists with an opportunity to showcase their creative talents and to challenge them from an artistic perspective through the field of portraiture. Identifies emerging artists and encourages them to have faith in themselves and their developing skills.	Originality and skills
The International History Bee and Bowl Asian championships	Thailand	International	All subjects	8,9,10,11,12,13,14,15,16,17,18	An all-subject quiz bowl tournament for school teams with questions from all academic disciplines	Aims to help students develop confidence, deepen subject understanding, and lead to friendships formed at tournaments.	Correct quiz, test answers
The US Academic Bee	USA	National	All subjects	13	An all-subject academic quiz competition for students	Aim to reward students for being well-rounded scholars whose intellectual curiosity drives them towards excellence inside and outside the classroom.	Correct quiz, test answers
The West Coast Baptist Fine Arts Competition	USA	National	All subjects	9,10,11,12,13,14,15,16	Provides students the option to participate in an annual interscholastic Fine Arts Competition	The goal is to glorify Christ by providing an opportunity for students to compete in various areas. This competition also provides students a time to fellowship with other students in a Christ-honoring environment.	Students' minds and abilities for a life of service to Christ
UCT Mathematics Competition	South Africa	National	Math	13,14,15,16,17	Is an annual mathematics competition	Aims to popularise mathematics and to identify promising students and offer them opportunities for further development of their mathematical talents	Correct quiz,test answers
Ultimate STEM Challenge	UK	National	Science, Technology, Engineering and Math	11,12,13,14	A completion where students must use their STEM skills to tackle one challenge: reimagine a solution to a real-life problem	The competition is designed to stimulate creativity, build confidence and teamworking skills, and inspire young people to consider careers in STEM	Judges looks for projects that uses STEM, provides a prototype that help, work and stand out
UpStArt student art competition	UK	National	Art	13	An arts competition where painting, illustration, ceramics, mixed media, photography and sculpture pieces of any theme are accepted for judging	Aims at supporting emerging artistic talent and give students a chance to promote their work	Innovation, originality
Vans Custom Culture	USA	National	Art	14,15,16,17	Schools are challenged to design 2 pairs of shoes around 2 themes. In addition to designing shoes, schools will also be submitting an Impact Document reflecting how their school would be impacted by winning the grand price of $75,000 for their art program	to empower high school students to embrace their originality through art and design, as well as encourage students to pursue a career in the arts.	Overall Creativity, method, use of material, media, originality, imagination, ability to showcase new, meaningful concepts
Verizon App Challenge	USA	National	Science, Technology, Engineering and Math	11,12,13,14,15,16,17	This competition, invites students to create a mobile app that will solve a problem in their community.	Focuses on ideating concepts for mobile apps, and encourages students to learn about app development.	Innovative value
Victorian Schools' Games and App Challenge	Australia	National	Science, Technology, Engineering and Math	11,12,13,14,15	Participating schools work on creating games, apps, and the Challenge culminates in a showcase exhibition, where the best solutions are appointed	The Challenge highlights the role of the Digital Technologies, Critical and Creative Thinking curriculum areas and their contribution to building the Education State.	Critical and Creative Thinking, quality of product

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THE UTILIZATION OF VIRTUAL REALITY ON DEVELOPMENT OF THREE DIMENSIONAL VISUALISATION ON CHEMISTRY SUBJECT

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Abstract
The utilize of instructional media will assist the effectiveness of the learning process and the delivery of learning material. The development of 3D visualization media using virtual reality is done with the development model of Borg and Gall, namely from the stage of information gathering, the planning stage, the initial development stage, the initial trial phase, and the main product revision stage. Development of instructional media is validated by media experts, material experts, subject teachers, and tested it into the 25 students of State High School 2 of Ternate City. Validation results from experts and subject teachers receive eligibility in a positive category. 3D visualization media using virtual reality chemical equilibrium material is tested on students and the results obtained by appropriate learning media are in good category. The overall results of the validation of experts, subject teachers and trials for students gained an average percentage of 76%. So that it can be concluded that the development of 3D learning media using virtual reality is declared feasible as a learning media for chemistry learning of class XI activities on chemical equilibrium material.

Keywords: Media Development; Virtual Reality; Chemical Equilibrium.

INTRODUCTION

Growing information technology presents numerous innovations in various fields. Likewise in the education system that gets the impact of the development of information technology. In the world of education, forms of learning activities using information technology are arranged to assist in constructing concepts in learning. The world of education also began to prepare the delivery of material to students by using information technology capabilities, with the hope that the material delivered is capable to be easily understood by students and also can advance the quality of education especially in chemistry learning.

Chemistry is a subject that has abstract scientific studies (Effendy, 2002) and emphasizes the concept to microscopic (molecular) symbolic levels, and is classified as difficult subjects (Johnstone, 2000). Wu, Krajcik & Soloway (2000) also said that the ability of students to represent must be related to students' understanding of the basic concepts of chemistry. This makes many students have difficulty in connecting abstract concepts and make students feel difficult in studying chemistry. One of the chemical materials that requires representation ability is chemical equilibrium.

Karpudewan (2015) states that chemical equilibrium has a concept relating to submicroscopic events, so students must be able to represent it in the material. One of the sub-items in the equilibrium material is the factors that affect equilibrium is one of the chemical materials that requires a laboratory in the learning process, in accordance with its basic competencies, which is to investigate the factors that affect equilibrium by doing lab work in the laboratory. Laboratories in chemistry

learning in schools have functions such as to prove and develop concepts and theories, as a place to support class activities, conduct practicum, and a place to develop knowledge and skills (Herrani, 2015). Activities in the laboratory are also the most important part of chemistry learning, because it allows students to build their experience with concrete material.Karpudewan (2015) states that chemical equilibrium has a concept relating to submicroscopic events, so students must be able to represent it in the material. One of the sub-items in the equilibrium material is the factors that affect equilibrium is one of the chemical materials that requires a laboratory in the learning process, in accordance with its basic competencies, which is to investigate the factors that affect equilibrium by doing lab work in the laboratory. Laboratories in chemistry learning in schools have functions such as to prove and develop concepts and theories, as a place to support class activities, conduct practicum, and a place to develop knowledge and skills (Herrani, 2015). Activities in the laboratory are also the most important part of chemistry learning, because it allows students to build their experience with concrete material.

According to Tusiyam (2011) the function of the laboratory is to provide completeness for accepted theoretical lessons, provide and foster the courage to seek the nature of scientific truths from an object in the natural and social environment, adding skills in utilizing tools. Laboratories are very important to make abstract chemical concepts become concrete and make chemical material easier for students to understand (Altun, et al, 2009). Tatli and Ayas (2010) state that one of the most efficient ways of learning chemistry is through laboratories. Based on the results of the study obtained if 87.8% of students revealed the deepening of chemical material can be obtained through the implementation of practical activities and 89.3% of students agreed that practicum activities can help improve the understanding of chemical material learned (Jahro. 2009). The practicum can also provide better results for increasing the absorption of students in the practiced material. In addition to improvement in learning achievement, practicum can also improve the scientific attitude of students.

Based on the results of observations, it was found that there were still many schools that had not used laboratories to support learning. This is due to the deficiency of availability of tools and materials in the laboratory, chemicals materials require very high costs and also some experiments are too risky for safety. As a result, most of the theories presented are difficult to prove. In general it can be said that the implementation of activities in the laboratory is very important in chemistry learning, but for some reasons this activity cannot be carried out properly. Therefore, an alternative laboratory or media environment is needed to assist students connect the experiments they need and make participants feel safe when carrying out dangerous experiments, observe every detail of the trial process, capable to play an active role in learning and can help students and teachers in anticipating the limitations of time, tools and materials according to the needs of students.

One way to help students understand the material in the laboratory of chemical equilibrium is through the medium of learning. Media that can be used are embodied learning media technology with three-dimensional (3D). Three-dimensional visualization technology was introduced using Virtual Reality (VR) which is used for chemistry learning. Three-dimensional technology using virtual reality can assist students to overcome problems such as the limitations of tools and materials as well as practicum to build cognitive abilities and scientific attitudes of students.

METHODS

Research methods

The learning media of three-dimensional visualization using virtual reality in this study was developed with reference to the development model of Borg & Gall (1983), adaptation and combination of Borg & Gall (1983) development models, Borg & Gall development models namely (1) information gathering; (2) planning; (3) initial product development; (4) initial trial; (5) product revisions

Data collection

The development model of Borg & Gall is adjusted to the research objectives used to develop three-dimensional media using the virtual reality development stage used in this study as follows. First is the stage of gathering information from various sources relevant to research on the development of three-dimensional learning media using virtual reality. At this stage of information gathering is done through library research and needs analysis. Second is planning, This plan was carried out with the aim of preparing instruments, media presentation models, simulating media and all related to three-dimensional media development using virtual reality. Third the initial product development stage is carried out with several steps including compiling chemical equilibrium material that will be loaded in the learning media, Making learning media design and Making learning media. Learning media is assessed by material experts and media experts. Material experts are chemistry lecturers who assess chemical equilibrium material. The aspects assessed are learning aspects and material with 10 indicators. Aspects assessed by media experts are audio visual and software engineering with 10 indicators. The virtual reality learning media was also assessed by 5 subject teachers. The aspects assessed are learning, material, audio visual and software engineering which consists of 20 indicators. Assessment carried out by material experts, media experts and teachers using a questionnaire with a Likert scale. Fourth is trial beginning, this stage tested media to obtain media readability assessment by 25 students who aim to get the analysis and consideration for product improvement. Fifth is product revision improvement based on the results obtained as well as input and discoverings obtained.

FINDINGS

The 3D visualization learning media with virtual reality on chemical equilibrium material through the development of this research can be accessed using Android. This learning media can be used as a substitute or supplement to experimental activities in a real laboratory. The initial page of 3D visualization media application with virtual reality can be seen in Figure 1 below.

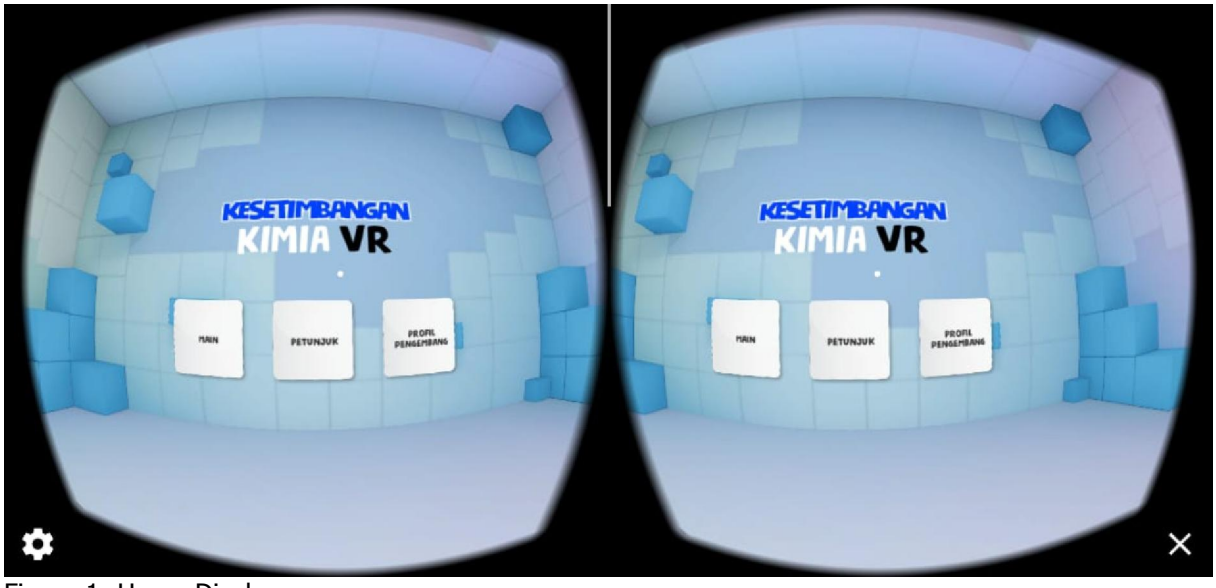

Figure 1: Home Display

Each experiment is equipped with an experimental procedure with a view instructions can be seen in Figure 2. Each user can perform a simulation lab experiment with selecting tools according to the procedure.

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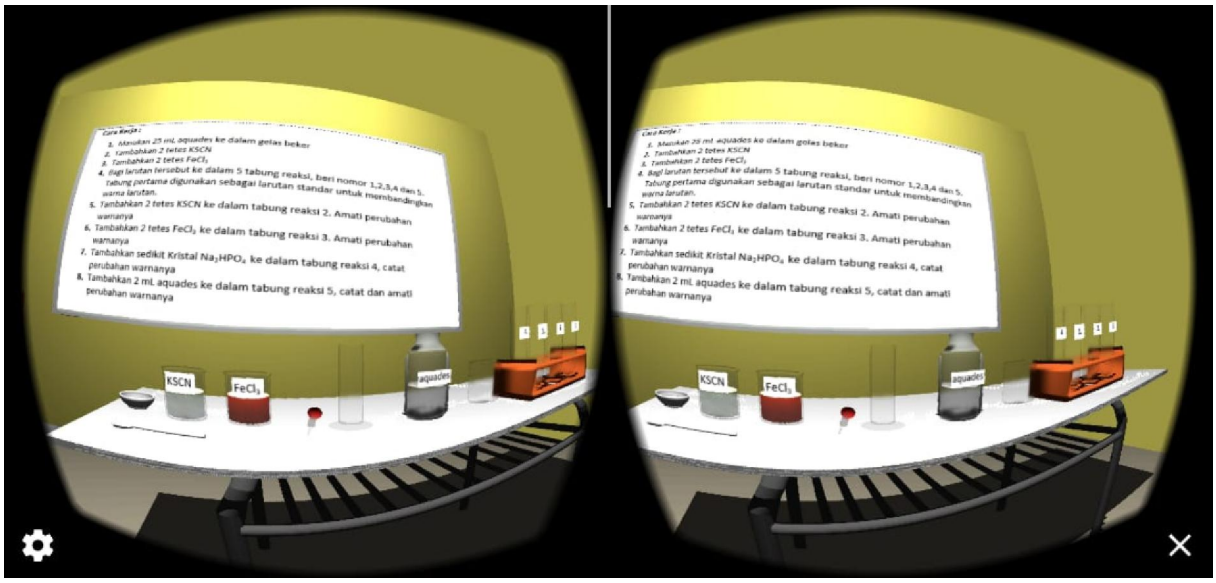

Figure 2: Experiment Display

Product Development Results

The study used 3D visualization media with virtual reality in chemical learning containing chemical equilibrium lab simulation. Data obtained from material experts, media experts, teachers and students were analyzed by calculating formulas and adjusted to the media eligibility criteria as found in Table 1.

Table 1: Criteria for Media Quality Categories

No	Score Range	Category
1	$\overline{X} > \overline{X}i + 1{,}8\ SBi$	Excellent (SB)
2	$\overline{X}i + 0{,}6\ SBi < \overline{X} \leq \overline{X}i + 1{,}8\ SBi$	Great (B)
3	$\overline{X}i - 0{,}6\ SBi < \overline{X} \leq \overline{X}i + 0{,}6\ SBi$	Sufficient (C)
4	$\overline{X}i - 1{,}8\ SBi < \overline{X} \leq \overline{X}i - 0.6\ SBi$	Bad (K)
5	$\overline{X} \leq \overline{X}i - 1{,}8\ Sbi$	Poor (SK)

The data obtained is used as a basis for determining the feasibility of 3D visualization media with virtual reality developed. Data in the development of 3D visualization media with virtual reality in the form of a general assessment of 3D visualization media with virtual reality developed from media experts, material experts, teachers and the opinions of students. The results of the 3D visualization media validation with virtual reality by experts can be seen in Table 2.

Media Assessment from Experts, Teachers and Students

Table 2: Media Assessment from Experts

No	Aspect	Grade	Category
1	Learning Aspect	3,8	Great
2	Material Aspect	3,8	Great
3	Audio Visual Aspect	3,7	Great
4	Software Engineering Aspects	4.5	Excellent

The results of the validation from the material experts focused on the learning aspects and material aspects and for media experts focused on audio visual aspects and software engineering aspects. The

quality of media from experts with an average of 3.95 demonstrates that the overall quality of the media from experts is categorized as great. The initial media products after being validated by experts were then validated by subject teachers. Aspects assessed by subject teachers are aspects of learning, material aspects, audio visual aspects and software engineering aspects. Aspects assessed by chemistry teachers with an average of 3.86 are included in the great category. Media assessments by subject teachers are listed in Table 3. below.

Table 3: Media Assessments from Teachers

No	Aspect	Grade	Category
1	Aspect Learning	3,72	Great
2	Material Aspect	3,68	Great
3	Audio Visual Aspect	3,7	Great
4	Software Engineering Aspects	4,35	Excellent

Media products after being assessed by experts and subject teachers, the assessment was also carried out by students including learning aspects and materials as well as audio visual aspects and media operations. The trial involved 25 students to use 3D visualization media with virtual reality and assess the media. Results of the assessment of media by the learner can be seen in Table 4. The results of the assessment test had an average value of 3.7 included in both categories.

Table 4: Media Assessment of Students

No	Aspect	Grade	Category
1	Learning Aspect and Material Aspect	3,52	Great
2	Display Aspect and Operational Media	4,01	Great

DISCUSSION AND CONCLUSION

The process of developing 3D visualization media with virtual reality was carried out by researchers based on the Borg and Gall development model with 5 stages, namely information collection, planning, initial product development, initial trials and major revisions.

In the stage of gathering information, the researcher gathered information about the media for learning 3D visualization with virtual reality and needs analysis. The curriculum used in State High School 2 of Ternate City is the 2013 curriculum. In addition to the curriculum researchers also review syllabi and indicators for chemical equilibrium material.

The planning stage, in planning the researcher prepares the media presentation model, makes the objects contained in the media and simulates media in accordance with the chemical equilibrium practicum in the real laboratory.

The initial development after learning media was designed, then 3D visualization media with virtual reality was validated by media experts and material experts to produce 3D visualization products with virtual reality. After that the learning media is given to subject teachers to be assessed and declared good to enter the initial trial stage. The initial trial was conducted by 25 students of Ternate State High School 2 High School.

Based on the results of the validation of the experts in Table 2. The results of media readability from the learning aspects and material aspects obtained great categories with a percentage of 76%, for the audio visual aspects of the good category with a percentage of 74% and software engineering aspects have a percentage of 90% with excellent categories. The results of 3D visualization media validation with virtual reality obtained an average percentage of 79%, then the development of 3D

visualization learning media with virtual reality was declared feasible as a chemical learning media for chemical equilibrium material.

Based on Table 3. The results of the validation of subject teachers observe from the aspect of learning included in the good category with a percentage of 74.4%, the material aspect has a percentage of 73.6% which is included in the great category, for the audio visual aspect the category is 74% and aspects software engineering has a percentage of 87% with an excellent category. The results obtained have an average percentage of 77.2%, the development of 3D visualization media learning media with virtual reality is declared feasible as a chemical learning media for chemical equilibrium material.

The results of the initial trial based on the opinions of students can be observes in Table 4. From the results of the assessment for aspects of learning and material included in the great category with a percentage of 70.4% and the appearance and operational aspects of the media has a percentage of 80.2% which is included in the great category. The results of the initial 3D visualization media using virtual reality obtained an average percentage of 74%, then the development of 3D visualization learning media using virtual reality was expressed as both a chemical learning media for chemical equilibrium material.

The overall results of 3D visualization media validation using virtual reality obtained an average percentage of 76%, the development of 3D visualization media using virtual reality was declared feasible as a chemical learning media for chemical equilibrium material. This result is supported by Riduwan (2011) which states that learning media can be said to be feasible if the average percentage of expert validation questionnaires, teachers and student responses is above 61%.

The use of 3D visualization media learning technology using virtual reality in learning makes participants more interested. In addition, it can improve learning and make learning more effective, increase the experience of students and also provide practical needs of students (Garrison and Akyol, 2009). The ability to create a variety of environments has made the virtual 3D world useful for reducing peril in science laboratories. Practical simulations in learning media help students who experience difficulties in learning (Urso & Fisher, 2015).Cerniglia (2011) says that learning must be done more creatively so that it can help students. 3D visualization using virtual reality makes students feel as if they are in a real laboratory. Students are more motivated in learning using a 3D virtual environment. The use of information, communication and technology can be a good opportunity to create chemical learning programs with effective tools to develop new methods and techniques in educational programs (Pekdag, 2010).

The development of 3D learning media using virtual reality consults to the development model according to Borg and Gall, which in this study only carried out several stages, namely the stage of information gathering, the planning stage, the initial development stage, the initial trial phase and the product revision stage. 3D visualization media using virtual reality that has been developed is feasible to be used as a learning media for chemical learning activities, namely chemical equilibrium based on the assessment carried out by media experts, material experts, teachers and students with a percentage of 76%.

Learning media becomes integral to teaching. In this modern era, learning media is certainly easy to obtain, but the media must also reach out to all students and be an alternative solution to students' lack of enthusiasm for learning. The technology developed using virtual reality environments can be used as an effective learning media, increasing student and interactive involvement. 3D visualization media using virtual reality can also help students who are still passive when in a real laboratory and can be an opportunity for future chemical learning media.

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