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Outdoor Learning Model through Fieldwork to Improve Physics Achievement in Dynamic Fluid

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ABSTRACT

This study aimed to describe the impact of the outdoor learning model on physics achievement for dynamic fluid. In this study, the outdoor learning activities were conducted through fieldwork. Fieldwork is one form of outdoor learning activities that emphasizes direct experience of students on the object being studied to link the theory to practice and improve students' skills in observation, measurement, data collection, and analysis. This study was a field trial test of physics learning model through observation to 32 students on the eleventh level physics class of senior high school in Yogyakarta Indonesia academic year of 2014/2015 as respondents. These were much divided into eight groups to do any fieldwork activities. The physics teaching and learning instructions consist of syllabus, lesson plans, worksheets, and four core competencies of assessment instruments. The instruments of data collection formed self-assessment sheet for spiritual attitudes, observation sheet for social attitudes, instrument test for physics knowledge, and observation sheet for skills. The instruments assessed the achievement of four core competencies of physics learning outcomes through fieldwork based outdoor learning. The data collected were analyzed by descriptive approach. The study states that the outdoor learning model through fieldwork which implemented can improve the core competencies of learning outcomes in dynamic fluid with the percentage of achievement of each competency is as follows: the competency of spiritual attitudes is 98%, the competency of social attitudes is 92%, the competency of physics knowledge is 78%, and the competency of skills is 92,5%.

Keywords: Outdoor learning model, fieldwork, physics achievement, dynamic fluid.

INTRODUCTION

Outdoor Learning characteristics, namely: (1) learning is done outdoors, but some aspects can be done in the classroom as an explanation of basic concepts and preparation of materials; (2) emphasis on experiential learning and learning process, namely action learning, learning by

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doing, learning through experience, and learn through discovery and exploration. One of the principles experiential learning in which students are actively involved in the learning process, such as asking questions, investigating, experimenting, curiosity, problem solving, responsibility, being creative and construct meaning. Students engage intellectually, emotionally, socially both interpersonal and intrapersonal and physical; (3) involves a good multi-sensory sight, touch, smell, hearing, taste, and intuition and involves three aspects of cognitive, affective, and motoric learning; (4) emphasis on relationship between human and natural resources (Priest, S., 1986).

Based on the field observations, only a minority of student active and pay attention to the physics learning process. Most of the students tend to be passive and give less enthusiastic response to physics learning. Outdoor learning is learning activities in the wild environment or activities outside the classroom that are enjoyable. Outdoor learning helps students develop thinking skills, develop an awareness of the complexity of the real world, and understand the relevance of learning materials in schools with everyday life. Outdoor learning can be a new learning experience which is more enjoyable, relaxed, and avoid saturation. Jones, S. (2010) as president Association for Science Education states in his report that fieldwork indicates all educational activities from early years through to post-16 which take place outside the classroom and make use of the outdoor natural and built environments. The School Garden Program (SGP) and evaluate its influence on primary school 5th grade curriculum mathematics objectives, such as formation and interpretation of figures, tables and graphs has been conducted by ÇEPNİ, S. et al (2013). It was understood that SGP is an effective program for the formation and interpretation of figures, tables and graphs and was especially found to be effective for male students and students with high visual and mathematical intelligence.

In addition, a multi-sensory experience outside the classroom helps students retain or recall of knowledge more effectively. Several studies have shown results that support this idea. The results of three case studies of Environmental Studies Programs (ESPs) in Canada have findings offering further documentation of the benefits of integrated ESPs, including increased student engagement, learning experiences that are practical and relevant to students' lives, experiential learning that is memorable and opportunities for development of social and interpersonal skills (Breunig, M. et al, 2014). Andersson & Ohman (2015) stated that outdoor experiences in outdoor education practices have relations with moral attitudes towards nature. Outdoor adventure education (OAE) is widely recognized for its ability to elicit personal and social development for its participants. However, the methodology highlights the need for carefully selected samples, use of an appropriate questionnaire and control of numerous variables (Scrutton, R. A., 2015). The nature-based learning is an increasingly popular type of early childhood education. Accordingly, the use of nature as a setting and a resource for learning was studied. Findings indicate that nature is utilized as setting, as resource and as educator within children's learning and this holds true within different countries. Local, social, and cultural contexts exert influence on pedagogical practice and implications for practice based upon these are given (MacQuarrie, S. et al, 2015). The present study explores the outcomes of teaching empathy and critical thinking to solve environmental problems. A community-based research methodology was used to understand the formation of empathy and critical thinking. The findings reveal a significant benefit in using empathy strategies to engage students regarding the thinking processes involved in solving environmental problems. Using these elements as teaching techniques for environmental education courses can be very helpful in reaching the aims of creating a sustainable citizenry (Ampuero, D. et al, 2015).

Dillon et al. (2006), in the School Science Review found strong evidence indicating that the fieldwork (outdoor learning) if it is well understood, planned adequately, and taught well this will offer students the opportunity to develop knowledge and skills and will add their experience. Fagerstam (2012) stated that students become active when taken to the outdoor learning. This is the same as that mentioned by Fagerstam & Blom (2012) in his study of teaching biology and mathematics that during the interview the group of outdoor learning was more evident in recalling the subjects, while the indoor learning unclear and confused in the given subjects. Students enjoy learning a new atmosphere and a pause from their daily routines was always learning in the classroom. Moreover, the interaction among students increased during outdoor learning process and most students showed a positive feeling in the learning process. In the research of Fagerstam (2012) the others mentioned that the outdoor teaching and learning improved collaboration among students and participation in group work. Outdoor teaching and learning improved relations between teachers and students and improved communication in the group work. Outdoor teaching has the potential to explain the learning material using a natural approach (the proximal nature). Results of research conducted by Okada et al (2013) with the aim of observing the effect of in-depth outdoor experience to the students' attitude to nature showed that children who were in the intensive group (outdoor deeper experience) obtained a significantly improved positive attitude towards nature when compared with children in the less intensive group (less deeply experience). Research conducted by the American Institutes for Research (2005), entitled " Effects of Outdoor Education Programs for Children in California " concluded that based on the average results of the assessment between learners and teacher assessment, elementary school students who took the program of science education in the outdoors demonstrated achievement of personal and social skills higher than the group of students who did not follow the program, especially at the point of problem solving. Clear evidence that outdoor learning increases knowledge and understanding of the natural world and environmental systems and processes related to responsible attitudes towards the environment. Outdoor learning can connect learners with their environment, their community, their society, and themselves (Higgins, P. et al, 2002).

The benefits of the study are as follows:

1. For schools, obtaining a product of physics teaching and learning instructions that conform to the fieldwork-based outdoor learning model for dynamic fluid material. The teaching and learning instructions consist of syllabus, lesson plans, worksheets, as well as instruments to assess the achievement of four core competencies that include spiritual attitudes, social attitudes, knowledge, and skills.
2. For teachers and researchers, this study can be used as materials to develop outdoor learning models based on fieldwork in other subject matters.
3. For students, providing a different learning experience through outdoor learning model based on fieldwork and providing opportunities to develop attitudes, knowledge, and skills.

In this study, the outdoor learning activities are directed to fieldwork. Fieldwork is one form of outdoor learning activities that emphasize direct experience of students on the object being studied to link theory to practice and improve students' skills in observation, measurement, data collection, and analysis. About study of the role of fieldwork in learning, Rickinson, M. et al. (2004: 20) concluded that the fieldwork has a positive impact on long-term memory due to the impressive nature of fieldwork activities. In the affective domain, fieldwork impacts on the development of individual and social skills. Cognitive and affective domains mutually influence each other in the learning process. The implementation of outdoor learning model through

fieldwork in physics learning needs preparation of teaching materials, location, materials and tools used in the field work, and learning equipments. Teaching materials used in this study is dynamic fluid because the material is suitable learned through fieldwork activities outside the classroom and the availability of facilities in the school environment. It has a source of tap water in every front yard of class that supporting the learning process.

METHODS

a) Participants

This study was a field trial on the development of the outdoor learning model through fieldwork (Thiagarajan, S., 1974). The field trial used a set of teaching and learning instructions and data collection instruments. The study was conducted through physics learning by observation to 32 students of the eleventh level physics class of senior high school in Yogyakarta Indonesia academic year of 2014/2015 as respondents from February to March 2015. The participant was much divided into eight groups to do any fieldwork activities. The physics teaching and learning instructions consisted of syllabus, lesson plans, worksheets, and assessment instruments of four core competencies. The instruments of data acquisition formed self-assessment sheet of spiritual attitudes, observation sheet of social attitudes, instrument test of physics knowledge, and observation sheet of skills. Through the instruments the achievement of four core competencies in physics learning with outdoor learning model was measured through fieldwork. The data collected were analyzed by descriptive approach.

b) Teaching and Learning Instructions

1. Syllabus
   According to the Regulation of the Minister of Education and Culture of the Republic Indonesia Number 65 Year 2013 on the Standard of Primary and Secondary Education Process, syllabus was used as a reference in the development of the implementation plan of teaching and learning. The syllabus at least contains the identity of subjects, school identity, core competencies, basic competencies, subject matter, lesson plan, assessment, time allocation, and learning resources. The syllabus used in this study is consistent with the national curriculum that is known Curriculum-2013 (Regulation of the Minister of Education and Culture of the Republic Indonesia, 2012).
2. Lesson plan
   Lesson plan was developed from the syllabus to guide the learning activities of students in an effort to achieve the basic competency. Learning steps in the lesson plan in this study were adapted to the outdoor learning model through fieldwork supported by group discussion method.
3. Student worksheet
   Student worksheet is developed on the basis of the learning objectives that were adapted to the outdoor learning model through fieldwork.

c) Data Collection Instruments

The instruments used in this study consists of the followings.

1. Validation Sheet
   This sheet was used to determine the feasibility of the developed products, so the instruments which were made should measure what we want to measure. The validation instruments were

performed by expert (lecturers) and practitioner(teachers). In this study, the validation sheet contained aspects that should be assessed using a rating scale. Every score in the assessment criteria was described in the assessment rubric for each instrument validated.

2. Self-Assessment Sheet for Spiritual Attitudes
   Self-assessment sheet was used to measure the aspects of spiritual attitudes. The statements in the self-assessment of the spiritual attitudes were described from the spiritual dimensions adapted from the basic competencies. The scale on this questionnaire was Guttman Scale, that is 'Yes' or 'No'. The statements in the self-assessment sheet were formulated from aspects of the spiritual attitudes: ideologically dimensional, experiential, intellectual, consequential, and ritual.
3. Observation Sheet for Social Attitudes
   The observation sheet was used to measure the aspects of social attitudes of the students during learning activities took place. The rubric of indicators were observed on the basis of the dimensions of social skills that were peer relationships, self-management, academic ability, compliance, and assertive behavior.
4. Physics Knowledge Test (Pretest and Posttest)

   Physics knowledge test was used to measure the cognitive aspects of physics achievement of dynamic fluid. The pretest was conducted to determine students' initial knowledge about dynamic fluid, while the posttest was conducted to measure students' knowledge about dynamic fluid after getting outdoor learning activities through fieldwork. In this study, the test consisted of 20 multiple choice items with five options about the characteristics of ideal fluid, the concept of flow, the law of continuity, the application of the principle of continuity in real life, the principle of Bernoulli, and the application of Bernoulli law in technology.
5. Observation Sheet for Skills
   The observation sheet was used to measure the students' skills in conducting fieldwork activities. The components of skills should be observed are preparing, observing, measuring, analyzing, and communicating.
6. Questionnaire for Students Response The questionnaire was used to get response of the students to the learning model implemented. All statements in the questionnaire related to the contribution of the outdoor learning model through fieldwork in providing the learning experiences with concrete objects, in providing the opportunity to interact with peers and teachers, as well as its contribution to increase the interest and motivation of the students.

FINDINGS

Validation

Data analysis included analysis of the feasibility of learning tools and instruments of research and analysis of the achievement of core competencies. Feasibility of data collection devices and instruments obtained from the lecturer and practitioner validation. Validation aimed to evaluate the teaching and learning instructions and the data collection instruments (Thiagarajan, S., 1974). The results of the validation by two validators to the teaching and learning instructions and the data collection instruments are described in Table 1.

Table 1 The Results of Validation of Teaching and Learning Instructions and Data Collection Instruments.

Teaching and Learning Instructions and Data Collection Instruments	Average score from two validators	Criteria
Syllabus	3.42	Very good
Lesson Plans	3.58	Very good
Worksheet	3.50	Very good
Spiritual attitudes assessment sheet	3.50	Very good
Social attitudes assessment sheet	3.13	Good
Skills assessment sheet	3.13	Good
Questionnaire of students response	3,33	Very Good
Physics test (pre-test and post-test)	4	Very Good

Based on Table 1, it means that all instructions and instruments can be used to collect research data.

Achievement of the Core Competencies

Spiritual attitudes

Spirituality is the conviction in conjunction with the God. Reveals that spirituality as the concept of the two dimensions of the vertical and horizontal dimensions. The vertical dimension is one's relationship with God, and the horizontal dimension is one's relationship with oneself, others, and the environment. The spirituality as something that multidimensional, ie existential dimension which focuses on the objectives and the meaning of life and religious dimension which focuses on a person's relationship with God (Mickley et al, 1992), (Stoll, 1989).

The first core competency is spiritual attitudes (Mickley et al, 1992), (Stoll, 1989) measured with self-assessment sheet filled out by each student. The Achievement of Spiritual Attitudes is presented in Table 2.

Table 2 The Achievement of Spiritual Attitude Competency

Aspects	Dimensions	Level of Achievement(%)
Religious	a. I believe that the universe and everything in it is a creation of God	100
	b. I believe that the pressure of the fluid and the speed of the fluid interplay is the will of God	100
	c. I submit the results of the work / exams to God when I have prayed and attempted with a maximum	100
Experiential	a. I was afraid of cheating during exams	100
	b. I know that cheating is a sinning action	97
Intellectual	a. I understand that by science, humans can exploit natural resources and use it in technology	100

	b. I understand that the fluids (air, gas, water) play an important role for the sustainability of life on Earth	100
Consequential	a. I use a fluid (water, gas) with an efficiency	88
	b. I contribute to protecting the environment as a form of gratitude	100
	c. As a form of gratitude for having understood the dynamic fluid, I help any friend who had difficulties to understand the material.	84
Ritual	a. I pray before starting the lessons in earnestness	100
	b. I pray after finishing the lessons in earnestness	97
	c. I express the gratitude for all the gifts of God according to my religion with oral	100
	Achievement	98

Based on Table 2, each dimension of the spiritual aspects has a percentage of achievement greater than 75%, which means the spiritual aspect has been achieved and the whole subject of research have reached a minimum mastered criteria with very good category (Borich, 1994: 385).

Social attitudes

Social attitudes associated with the social skills of the individual that builds social attitudes. Social attitudes could be described of how one uses social skills that they have. According to describes of social skills, namely: (1) attitude required learners to interact well with another people, (2) demonstrate that proper social attitudes repeatedly and consistent, (3) the interaction between two or more persons involving an action. The interaction is positive, effective, and valued by the community Jessica & Johnny (2009: 61), Young, E. L. et al (2012: 64).

Analysis of the achievement of the second core competency, namely social attitudes was done using data obtained from the observation sheet at the first, second, and third meetings. The average achievement of every aspect of the social attitudes derived from three times observations are presented in Table 3.

Table 3 *The Achievement of Social Attitudes Competency.*

Aspects	**Level of Achievement (%)**
Cooperation	95.3
Tolerance	93.8
Manners	95.9
Academic ability	87.0
Discipline	92.2
Responsibility	94.3

Assertive behavior	84.4
Average achievement	92.0

Based on Table 3, every aspect of the social attitudes shows a percentage greater than 75%, which means that every aspect of social attitudes has been achieved with an average percentage of achievement for all aspects of 92%. In addition, as many as 97% of research subjects have achieved a minimum criteria of completeness, namely the level of achievement which is categorized as very good and good proportions as presented in Figure 1.

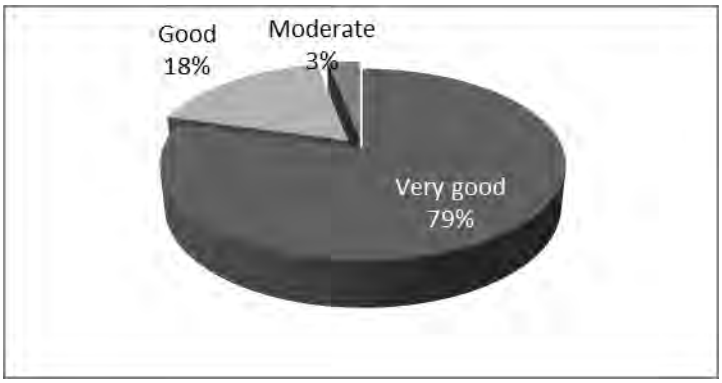

Figure 1 The Proportion of Social Attitude Achievement

Based on the results of the analysis it can be stated that the outdoor learning model through fieldwork can be used to achieve the competence of social attitudes.

Physics knowledge

Physics knowledge that be achieved is dynamic fluid which are steady or laminar flow, turbulent flow, continuity equation, debit, Bernoulli's law, the application of Bernoulli's law, pitot tube, venturimeter pipe, Torricelli theorem.

The reliability of the physics instrument test was determined by using the ITEMAN program 3:00 and was interpreted according to Triton (2006: 248). Analysis of the achievement of the third core competency, namely physics knowledge was done using data obtained from the results of the pre-test and post-test. The results of pre-test and post-test of dynamic fluid material are presented in Table 4.

Table 4 *The Achievement of Dynamic Fluid Material*

Analysis	Pretest	Posttest
Lowest score	10.53	52.63
Highest score	57.89	94.74
Average score	37.17	80.76
Standard deviation	11.02	10.99
Number of not mastered (%)	100	21.9
Number of mastered (%)	0	78.1

Based on Table 4, the improvement of the physics competency of dynamic fluid material can be known through the standard gain which is 0.7 being a high category (Hake, 2012: 1).

In the form of a bar chart the increasing average score of the cognitive ability test are presented in Figure 2.

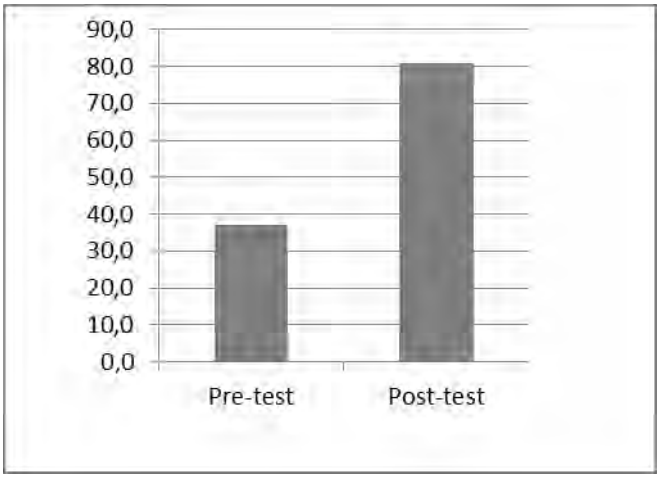

Figure 2 The Average Score of Cognitive Ability Test

In addition, the post-test results show the percentage of students who achieve a minimum of mastered criteria, it is 78.1%. This shows that the overall grade achieves good knowledge competence.

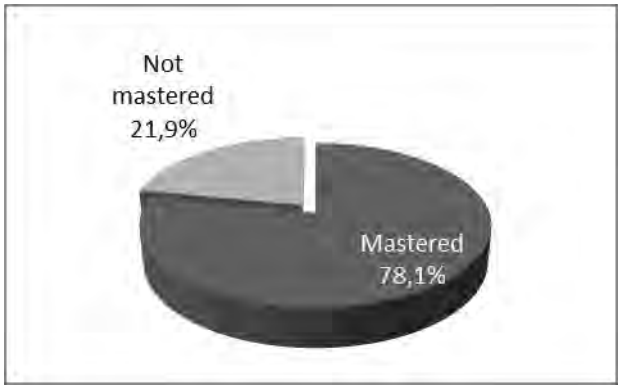

Figure 3 The Proportion of Physics Knowledge Competence

Skills

Skills are the abilities to complete the task. In Indonesia regulation about the standard of teaching and learning process, the skills acquired through some activities i.e. observing, asking, trying, reasoning, describing, and creating in accordance with the competency in each subject.

Analysis of the achievement of the fourth core competency, which is the skills in conducting fieldwork outside the classroom was done using data obtained from the observation sheet. The average achievement in every aspect of the skills assessed by three times observations is presented in Table 5.

Table 5 *The Achievement of Skills*

Aspects	Level of Achievement (%)
Preparing	96.9
Observing	92.7
Measuring	91.7
Interpretating	94.8
Communicating	86.5
Average Achievement	92.5

Based on Table 5, each of the aspects of skills assessed by three observations shows that the average percentage of achievement is greater than the passing grade 75%. This means that the student's skills in doing fieldwork achieved very good category (Borich, 1994: 385). In addition, all the aspects reached a minimum of mastered criteria. This can be achieved because the activities of fieldwork were carried out in groups with each group consists of four students, so that everyone in the group gets their respective duties and in turn they help each others in the group. The achievement of skills is represented in Figure 4.

Figure 4 The Proportion of Skills Achievement

So, it can be concluded that the outdoor learning model through fieldwork can be used to achieve students' skills.

This study also collected data about students' response to the developed model. Based on the analysis, the students showed a very good response and positive comments on the learning model implemented. A statement of students that shows the most positive response is that physics learning through fieldwork outside the classroom may make learning physics become fun and enjoyable. The results of this study indicate that by the implementation of outdoor learning model through fieldwork, this gives students the opportunity to socialize, to develop skills and help to connect theory with practice related to the application of dynamic fluid in everyday life.

DISCUSSION

The results of this study evidently to be in line with several previous studies. The American Institutes for Research (2005: 37-38) concludes that students who take the program outside the classroom science education show higher achievement in solving the conflict,

concern for the environment, and understanding the concept of knowledge after the program. Spending time outdoor environments on young children's plays and responses to challenging environmental features supported the importance of accumulated experience and social context for the development of confidence in the face of risk, individual exploration and positive social support and engagement with peers (Whittington et al, 2016). Williams, C. et al (1999: 4) have studied the effects of fieldwork on student achievement and motivation in science education. These study states that fieldwork, especially fieldtrip improve understanding on the subject matter, increase understanding in development of students' skills of data collection, analysis, personal skills, and relationship between students and teachers. Other research on the effect of outdoor teaching and learning on the skills and attitudes of students in junior high school indicates that fieldwork activity has positive effect on academic achievement and motivation of learners. Showed that group outdoor learning is more evident in the recall of subjects rather than group indoor learning. Moreover, the interaction between students increased during outdoor learning process and all students showed a positive feeling in the learning process (Stephens & Block 2012).

Nature is important to children's development in every major way that are intellectually, emotionally, socially, spiritually and physically (Kellert, 2005). Benefits of Connecting Children with Nature reported by NC State University there are postive impacts include the following: supports creativity and problem solving (Kellert, 2005), enhances cognitive abilities (Wells, 2000), improves academic performance (American Institutes for Research, 2005), reduces attention deficit disorder (ADD) symptoms (Kuo & Taylor, 2004), increases physical activity (Bell & Dyment, 2006), improves nutrition (Bell & Dyment, 2008), (Waliczek, & Zajicek, 2006), (Morris & Zidenberg, 2002), (American Academy of Ophthalmology, 2011), improves eyesight (American Academy of Ophthalmology, 2011). improves social relations (Burdette & Whitaker, 2005), improves self-discipline (Taylor, Kuo & Sullivan, 2001), reduces stress (Wells & Evans, 2003).

ALKAN, F. (2016) stated that the experiential learning is an effective approach on academic achievement and scientific process skills. The impact of experiential learning on other variables can be identified. Study used meta-analysis method reviews the findings of the studies on the effectiveness of the inquiry-based science education comparing with traditional learning. showed that the inquiry-based science education had a positive and higher levels of effects of students' academic achievement. It was also found that this specific teaching and learning method had a positive and medium level of effect on their science process skills and attitudes towards science. It was found that the inquiry-based learning method used in science education had much more significant effects on student achievement rather than on their science process skills and their attitudes towards science in contrast to the traditional teaching method (AKTAMIÅ, H. et al, 2016). The effect of science activities designed by inquiry-based approach was investigated by ÖZDEMİR & IŞIK (2015). The study concludes with recommendations for further investigations to signify and overcome the barriers challenging the prospective teachers' adaptations and practices of science process skills and inquiry strategies. The effect of attitudes and behaviours towards environment of 4th grade students of environmental education based on interdisciplinary approach found that points for attitude and behaviour towards environment of students show significant difference for the benefit of first group among the groups. These facts showed that interdisciplinary approach is more effective than traditional method in the attitudes and behaviours towards environment of the students (HAMALOSMANOĞLU & GÜVEN, 2014).

CONCLUSION

From this research can be resulted a guidebook of outdoor learning management model through fieldwork to improve physics achievement in dynamic fluid material. Based on the result of assessment by validators consist of a physics lecture and a high school teacher declared that all of teaching and learning instructions eligible used for physics learning activities so that learners are able to achieve core competencies in dynamic fluid material.

Based on the analysis and discussion can be concluded that the outdoor learning model through fieldwork can be applied to achieve the core competencies in dynamic fluid material for senior high school students. The level of achievement for each core competency is as follows: the first core competency i.e spiritual attitudes is 98%, the second core competency i.e social attitudes is 92%, the third core competency i.e knowledge is 78%, and the fourth core competency i.e skills is 92.5%.

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