Educating high-ability students through different types of inquiry learning in primary schools

A study on flow, mood, and learning outcomes

Laurie Eikema

S1617206

Master Psychology – Learning Sciences

University of Twente

1st supervisor: Tessa Eijsink

2nd supervisor: Hannie Gijlers

Abstract

This study investigated the differences in mood, flow, and learning outcomes in three different types of inquiry based learning activities for high-ability students in pull-out classes. These types of inquiry learning were open inquiry, guided inquiry, and structured inquiry and differed in the amount of provided information and support. Ninety-five primary school students who were labelled as high-ability students and received education in a pull-out class for a portion of the week were selected for this research. The students were randomly assigned to one of three conditions; open inquiry, guided inquiry, or structured inquiry. Results showed no significant differences for either flow, mood, or learning outcomes among conditions. This means that the different conditions did not have a different effect for flow, mood, and learning outcomes. Students in all conditions expressed a positive mood and showed an experience of flow. An explanation for this could be that students were challenged sufficiently in all conditions and did not experience any differences in the amount of freedom they had to alter the research to their own interests. Furthermore, students in all conditions showed a similar improvement of domain-related learning outcomes over time. An explanation for this could be that learning outcomes of high-ability students did not depend on the amount of information and support that distinguished the three types of inquiry learning. Overall, the results of this study contribute to the conclusion that inquiry based learning can be an instructional strategy that generates a positive mood, an experience of flow, and an improvement of learning outcomes for high-ability students in pull-out classes.

Keywords: high-ability students; inquiry based learning; primary education; mood; flow; learning outcomes.

Introduction

In Dutch primary schools, around 10% of all students are gifted (Doolaard & Oudbier, 2010). Based on a research project of the Inspectorate of Education in 2010, nearly 25% of the primary schools in The Netherlands stated that extra arrangements for gifted students are not present within their curriculum. From this 25%, only a few schools stated to not have any gifted students in their schools and therefore do not have any extra arrangements (Inspectie van het Onderwijs, 2010). This leaves a substantial amount of schools without extra arrangements for their high-ability students. The lack

of extra arrangements is a problem, since many students do not reach their potential unless the curriculum responds to their needs and stimulates their learning (Rayneri, Gerber, & Wiley, 2006).

In 2014, the Dutch Ministry of Education implemented a law stating that all students should receive appropriate education, according to their educational needs. Educational needs for high-ability students include flexibility, independence, and self-selection of learning experiences (Ricca, 1984). Moreover, high-ability students have a need for complex tasks which addresses their analytical skills (Steiner & Carr, 2003). Addressing these needs by offering complex tasks in regular education is difficult (Mulhern, 2003) since students are grouped in homogeneous age groups where students might differ in terms of abilities and skills, learning styles, and motivation (Kahyaoglu, 2013). A solution is to offer education in a setting where students are placed in heterogeneous age and same-ability groups such as pull-out classes.

Placing high-ability students in pull-out classes offers possibilities to address their educational needs. A meta-analysis conducted by Vaughn, Feldhusen, and Asher (1991) indicated that participation in a pull-out class yielded positive results for high-ability students in terms of academic performance, critical thinking, and creativity. For students, it offers possibilities to collaborate with same-ability peers which could improve their learning results (Samardzija & Peterson, 2015). However, grouping same-ability students by itself is not effective, curricular adjustments have to be made in order for pull-out classes to be effective and beneficial (Kulik & Kulik, 1997). One way to adjust the curricular activities of high-ability students in pull-out classes appropriately is through inquiry based learning activities (Eysink, Gersen, & Gijlers, 2015).

Inquiry based learning activities consist of open and active learning tasks where students are encouraged to design and execute research (Eysink et al., 2015). High-ability students are expected to do well in inquiry learning activities because of their well-developed problem solving skills (Steiner & Carr, 2003). Inquiry learning tasks can differ in the amount of information and support that is given to students, each reflecting a different type of inquiry learning (Banchi & Bell, 2008). Based on the needs high-ability students have for independence and self-selection of learning experiences, the type of inquiry learning that offers the least amount of information and support might suit these students best. However, their educational needs are not the only factors that

should be taken into account. Since an optimal match between students' needs and the type of inquiry learning expresses itself in a positive mood and the experience of flow with consequently high learning results, mood and flow have to be considered as well when deciding which inquiry learning activities suit high-ability students best.

Pintrich (2003) states that activities should be relevant and useful to students in order for them to be motivated and interested. When fully engaged in an activity within an area of interest, a positive mood is triggered. A positive mood is considered an important factor for levels of achievement and performance (Phillips & Lindsay, 2006). Positive feelings towards a task lead to action in pursuing a certain task which could lead to flow (Renzulli, 2002). Students experience flow when they have an ongoing positive mood and interest for the activity they are in (Csikszentmihalyi, 2014). Students experience flow when they feel challenged appropriately according to their skills (Csikszentmihalyi, Abuhamdeh, & Nakamura, 2014). An optimal experience of flow can result in high learning outcomes for high-ability students. Therefore, mood and flow should be taken into account when designing education for high-ability students.

This study will investigate the differences in mood, flow, and learning outcomes in three different types of inquiry based learning for high-ability students in pull-out classes. The results of this study contribute to the development of appropriate extra arrangements for high-ability students in pull-out classes.

Theoretical framework

Inquiry based learning

Inquiry based learning is an instructional strategy where students are encouraged to use their problem solving skills (Pedaste et al., 2015). Students follow methods and practices similar to those of professional scientists (Keselman, 2003) in order to acquire domain-related knowledge. Inquiry learning requires active participation of students and responsibility for the content being learned (de Jong & van Joolingen, 1998). Inquiry learning is a complex process that can be divided into smaller, more comprehensive parts. Based on a review of various studies on inquiry learning processes, Pedaste et al. (2015) constructed an inquiry cycle. This cycle consists of several smaller inquiry phases including Orientation, Conceptualization, Preparation, Investigation, Conclusion, and Presentation. Research points out that students often encounter problems when

working through these inquiry phases (de Jong & van Joolingen, 1998). To overcome these problems, students should be provided with a supportive structure or more information (de Jong & van Joolingen, 1998). The amount of support or information that is provided determines students' success in the inquiry learning activity. According to Banchi and Bell (2008), the amount of information and support that is given in inquiry learning activities differs for each type of inquiry learning.

Banchi and Bell (2008) distinguished four types of inquiry learning: confirmation inquiry, structured inquiry, guided inquiry, and open inquiry. In confirmation inquiry, the research question, method, and results are provided. The student only has to generate the conclusion. This type of inquiry learning familiarizes students with the structure of inquiry learning and helps them to learn what inquiry learning is about. Since students are not actively involved in the execution of research, this type of inquiry learning will not be used in this study. In structured inquiry, the research question and methods are provided as well, but the student needs to generate a conclusion based on self-obtained results. In guided inquiry, only the research question is provided. The method for research has to be designed by the student, and the corresponding results and conclusion have to be generated by the student as well. In open inquiry, students are expected to formulate a research question and corresponding method within a given domain. Then, they have to execute their research and obtain their results (Banchi & Bell, 2008). Since this study focuses on high-ability students, their characteristics have to be explored in order to provide them with suitable inquiry learning activities.

High-ability students

High-ability students score above the average on standardized tests on different core subjects in regular education (Cito, 2011) and are expected to be capable of learning under most conditions (Subotnik, Olszewski-Kubilius, & Worrell, 2011). Research points out that a lot of people believe that high-ability students will make it on their own no matter what educational environment they are placed in (Swiatek & Lupkowski-Shoplik, 2003). However, high-ability students should be challenged appropriately in order to be motivated for learning and develop knowledge (Phillips & Lindsay, 2006). Moreover, when high-ability students have a low motivation and negative attitude towards school, problems such as underachievement could arise (McCoach & Siegle, 2003; Mooij, 2013). Underachievement can best be described as a severe discrepancy between expected

achievement and actual achievement (Reis & McCoach, 2000). In order to prevent underachievement, high-ability students should be offered education in an environment that responds to their learning needs and preferences.

High-ability students are curious learners who have good problem solving skills such as a good understanding of the problem that needs to be solved and quickness in creating a solution to this problem (Steiner & Carr, 2003). This relates to inquiry learning in the sense that students are expected to generate their own research question or method and execute research according to this method (Banchi & Bell, 2008). Furthermore, high-ability students have good metacognitive skills, which makes them good at monitoring their work and what they have and have not learned (Steiner & Carr, 2003; Laine & Tirri, 2015). This is needed in inquiry learning, where students are expected to work through the phases of the inquiry cycle independently. Overall, high-ability students like to work on a challenging and complex learning task, which is provided within an inquiry learning environment (Phillips & Lindsay, 2006; Eysink et al., 2015).

Flow

The presence of challenging and complex learning tasks is also an important requirement for the experience of flow. Csikszentmihalyi (1975) described flow as a positive psychological state that is challenging, intrinsically rewarding, and enjoyable. Moreover, students will experience flow when they are completely immersed in an activity, maintain a sense of control, and feel involved in meaningful actions (Csikszentmihalyi, 2014). Bressler and Bodzin (2013) report that in order for high-ability students to stay in flow, they need to continue to discover new challenges. Phillips and Lindsay (2006) also state the importance of challenge for high-ability students and how this challenge should be appropriate and consistent. Whether challenges are appropriate and consistent depends on students' knowledge and abilities.

Inappropriate challenges could either be too demanding or too easy. Demanding challenges could be present in open inquiry if students do not have the right abilities and skills to complete the tasks that are presented. On the other hand, if students are not challenged sufficiently, they could get bored and their mood and experience of flow could be affected adversely (Clinkenbeard, 1994). This might be the case in structured

inquiry. A balance between perceived challenges and skills and a clear set of goals lead to the highest level of flow (Csikszentmihalyi et al., 2014).

Mood

Whereas challenge in the learning task leads to a high level of flow, it is also an important requirement for the experience of a positive mood (Phillips & Lindsay, 2006). Experiencing a positive mood while learning results in high-quality learning and creativity (Ryan & Deci, 2000). Moreover, Zafra-Gómez, Román-Martínez, and Gomez-Miranda (2015) report that students experience more interest in the subject when students experience a positive mood towards inquiry learning. In inquiry learning, if students have the choice to investigate a question they are interested in, it is more likely that they will engage in the research process and experience a positive mood towards this process (Moeed, 2015). This will most likely be the case in open inquiry. However, a positive mood can also be triggered when students are allowed to experiment on their own, or when they have the choice in how to complete things (Jones et al., 2015). These types of activities are found in all types of inquiry learning; in structured inquiry, students are allowed to experiment and obtain results themselves, whereas students in guided inquiry also have to design the research themselves. Nevertheless, students in open inquiry experience the greatest amount of choice since they design their own research while only the domain is provided. It is therefore expected that students in open inquiry experience the most positive mood throughout, whereas students in guided inquiry and structured inquiry experience a less positive mood throughout the different phases of the inquiry cycle.

Learning outcomes

Appropriate education that is designed especially for high-ability students leads to higher learning outcomes for these students (Delcourt, Cornell, & Goldberg, 2007). The study of Delcourt et al. (2007) focused on special programs like pull-out classes for high-ability students. In these pull-out classes, students were encouraged to pursue their own investigations with the goal to improve their academic results. This approach has similarities with inquiry learning where students have to design and execute research in a certain domain as well. Hushman and Marley (2015) found that when the goal is to design experiments, guided inquiry is a better instructional strategy than structured or open inquiry. This result might have to do with the fact that students need some

structure on how to design these experiments, but also need the freedom to conduct these experiments according to their own interests. When all details are framed, as it is within structured inquiry, they lack this freedom (Spronken-Smith & Walker, 2010). Overall, inquiry learning could be an instructional strategy which leads to an improvement of domain-related learning outcomes when especially designed for high-ability students.

Even though Woods-McConney, Wosnitza, and Sturrock (2016) state that students first need to know what inquiry based learning is before it enhances their academic performance in science, this does not seem to match the preferences of high-ability students. High-ability students have a need for independence and self-selection of learning tasks (Ricca, 1984). Moreover, high-ability students are expected to learn with minimal instruction and to work independently on their own assignments outside class (Kettler, 2014). These statements would suggest that high-ability students are not dependent of background information before they start learning and will probably benefit most from open inquiry. Since there seems to be a gap between theory and practice, this study will investigate whether mood, flow, and learning outcomes differ for high-ability students in three different types of inquiry learning.

Research question

What differences on mood, flow, and learning outcomes can be found for high-ability students in pull-out classes in three different types of inquiry based learning?

Subquestions

1. Which type of inquiry based learning generates the highest flow experience?
2. Which type of inquiry based learning generates the most positive mood?
3. To what extent does mood differ for the different phases of the inquiry cycle?
4. Which type of inquiry based learning generates the highest increase in domain-related learning outcomes?

Research design

This research will have three conditions, each reflecting a type of inquiry learning as described by Banchi and Bell (2008): (1) open inquiry, (2) guided inquiry, and (3) structured inquiry. In this research, all participants are high-ability students who have no experience with inquiry learning.

Hypotheses

According to Csikszentmihalyi (2014), students will experience flow when the activity contains a clear set of goals. Moreover, Csikszentmihalyi et al. (2014) state that students should experience balance between perceived challenges and skills. High-ability students are unlikely to experience flow when tasks are perceived as too easy, even when they are unexperienced. This might be the case in structured inquiry. Tasks that are too demanding might be present in open inquiry, which might also lack a clear set of goals. In guided inquiry, the balance between perceived challenge and skills is expected to be optimal and the activity still contains a clear set of goals. Therefore, unexperienced high-ability students are expected to experience the highest levels of flow in guided inquiry.

Phillips and Lindsay (2006) and Ryan and Deci (2000) state that choosing content in students' own area of interest leads to a positive mood. Jones et al. (2005) found that when students are allowed to experiment on their own, this improves their mood. Both components are found to the greatest extent in open inquiry learning settings. This leads to the hypothesis that open inquiry learning leads to a more positive mood among high-ability students than structured inquiry and guided inquiry. Since students in guided inquiry are still allowed to choose their own content, guided inquiry is thought to lead to a more positive mood than structured inquiry, where students experience the least amount of choice and freedom.

Students in all conditions are allowed to experiment and draw conclusions on their own during the Investigation, Conclusion, and Presentation phase. It is therefore expected that students in all conditions experience an equally positive mood in the Investigation, Conclusion, and Presentation phase. Students in the open and guided condition are allowed to complete the tasks in the other phases according to their own interests as well. It is therefore expected that students in the guided condition experience an equally positive mood as students in the open condition in the Preparation phase and that students in the open condition experience the most positive mood in the Orientation and Conceptualization phase.

Learning outcomes will be measured in terms of domain-related knowledge. In this study, participants have no experience with inquiry learning which might cause difficulties in open inquiry since they do not have conditional information on how to

perform research (Woods-McConney et al., 2016). In structured inquiry, students can rely on given information, but they might lack freedom to design their research according to their own interests (Spronken-Smith & Walker, 2010). In guided inquiry, students still experience some structure and information on how to perform their research, but also certain degrees of freedom to alter the research to their own interests and abilities which could lead to higher learning outcomes (Spronken-Smith & Walker, 2010). Thus, guided inquiry is expected to generate the highest increase in domain-related learning outcomes.

To summarize, open inquiry is expected to lead to the most positive mood among conditions, but also throughout the different phases of the inquiry cycle. Guided inquiry is expected to generate the highest level of flow and the highest domain-related learning outcomes.

Method

Participants

Ninety-five students (47 F, M_{age} = 9.72, SD = 1.29) from six different schools participated in this study. All students attended a pull-out class. Students in this study either scored higher than 130 on an IQ test or scored highest on three of four standardized tests by CITO, labelling them as high-ability students. Parents of all participants signed an informed consent form. Their regular teacher was responsible for creating dyads and made sure that every student was matched with a similar-aged peer who had the same prior domain-related knowledge. All dyads were then randomly assigned to one of the three conditions. Students were unaware of the condition they were in. The open condition consisted of 31 students (16 F, M_{age} = 9.84, SD = 1.24), the guided condition consisted of 32 students (19 F, M_{age} = 9.63, SD = 1.21), and the structured condition consisted of 32 students (12 F, M_{age} = 9.69, SD = 1.42).

Design

In order to generate an answer to the research question, an inquiry based learning activity was created that consisted of two different sessions. The subject of this activity was the bouncing of balls. This subject was chosen because of the fact that all students were able to connect to this subject and it offered a lot of possibilities for investigation. Within this study, three different conditions were distinguished. Students in the open

condition received the same introduction on inquiry learning and structure as the other conditions, but they had to generate their own research question and method to investigate their research question. Students in the guided condition were provided with a research question, but had to design the method to investigate this question with the information and questions that were presented on their worksheet. Students in the structured condition could, for the most part, rely on the research question and method that was already filled in on their worksheet. A more detailed description on how the worksheets differed for the three conditions can be found in the Materials section.

Procedure

The inquiry activity consisted of two sessions, each lasting 60 minutes. The first session consisted of the first three phases of the inquiry cycle (Orientation, Conceptualization, and Preparation), while during the second session the last three phases of the inquiry cycle were covered (Investigation, Conclusion, and Presentation). The first session started with a general introduction, after which the students filled in the pretest to measure their domain-related knowledge. The general introduction and pretest lasted 10 minutes. After this test, a 5-minute introduction on inquiry learning and the phases of the inquiry cycle followed. Then, students started working on their worksheets where they had to make assignments belonging to different phases of the inquiry cycle. Students worked on their worksheets for 40 minutes. After each phase, students filled in the smiley-o-meter to indicate their mood at that time. At the end of the first session, the Flow Short Scale was presented. In the second session, students continued to work on their worksheets. Again, they did this for 40 minutes and after each phase, students self-reported their mood with the smiley-o-meter. After finishing all phases on their worksheet, students were presented with the Flow Short Scale and the posttest which measured their domain-related knowledge after the two sessions. The posttest and Flow Short Scale lasted 20 minutes.

Materials

Worksheets

To guide students through the sessions and different parts of the inquiry process, worksheets were used. There were three different worksheets: an open inquiry; a guided inquiry; and a structured inquiry worksheet, matching the three different

conditions. The open inquiry worksheet can be found in Appendix 1, the guided inquiry worksheet in Appendix 2 and the structured inquiry worksheet in Appendix 3. The worksheets were designed following the theory of Banchi and Bell (2008), providing students in the structured condition with the most amount of information and support, and students in the guided and open condition with more freedom and choice to design their own research. Table 1 provides an overview of the given information regarding the research question and method per condition. The content of this given information can be found in Figure 1.

Table 1: Overview of differences in given information regarding research question and method on worksheets between conditions.

	Open condition	Guided condition	Structured condition
Research question: Our research question is:	Not given	Given	Given
Method: This is how we will investigate our research question:	Not given	Not given	Given

Given answer to research question: Our research question is:

What determines the bouncing height of balls?

1. *When will a ball bounce highest; when a ball is made from leather or rubber?*
2. *When will a ball bounce highest: when it bounces on sand, stone, or wood?*
3. *When will a ball bounce highest: when you drop it from halve a meter or a meter?*

Given answer to method: This is how we will investigate our research question:

You will compare a leather and a rubber ball. You will compare these balls on a sand, stone, and wooden surface. You will drop both the leather and the rubber ball from halve a meter and a meter. This will be done on all three surfaces. In total, you will drop each ball six times.

Figure 1: Content of given answers on worksheets.

Mood

Mood was measured with the smiley-o-meter (Read, 2008). The full measurement can be found in Appendix 4 and an example of the smiley-o-meter that was used in this study can be found in Figure 2. On the smiley-o-meter, students self-reported how they felt after performing tasks in each phase of the inquiry cycle. In total, students indicated how they felt six times in two sessions. They did this by making a distinction between five smileys, ranging from 'bad' to 'great'. The scores were translated onto a five point Likert scale, where 'bad' got 1 point and 'great' received 5 points. Thus, the maximum score for each phase in the inquiry cycle was 5.

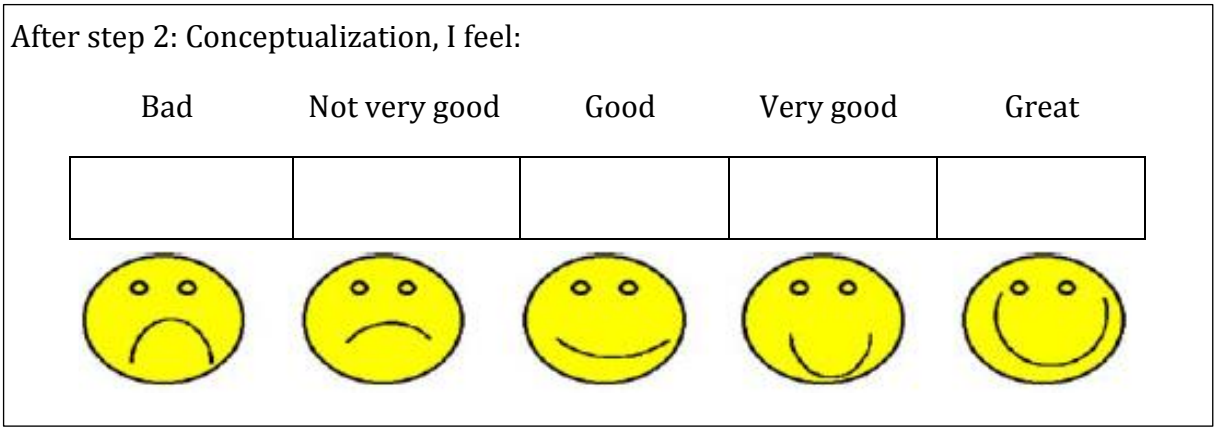

Figure 2: Example of Smiley-o-meter by Read (2008).

Flow

Flow was measured with the translated version of the Flow Short Scale of Rheinberger, Vollmeyer, and Engeser (2003). The full version that was used in this study can be found in Appendix 5, an example question can be found in Figure 3. The flow scale consisted of nine items which all measured components of flow experience. Students had to rate every item on a seven point Likert scale, where a lower number indicated a higher flow experience. These scores were recoded before data analysis, making it easier to read. Flow was two times, both at the end of each sessions. Consequently, the minimum score for flow was 18 and the maximum score was 126. The reliability of the flow scale, as measured with Cronbach's α, was .89.

	True					Not true	
I felt in control of what I was doing	1	2	3	4	5	6	7

Figure 3: Example question of Flow Short Scale of Rheinberger et al. (2003).

Learning outcomes

The learning outcomes focused on the domain-related knowledge of the inquiry learning activity. There was a pretest and a posttest that addressed different constructs of the domain central to this lesson: the bouncing of balls. The pretest can be found in Appendix 6 and the posttest can be found in Appendix 7. Both tests were scored according to the same answer key. For every question, a maximum score was set which led to a maximum score of 46 for the pretest and the posttest.

Pretest: The pretest consisted of 5 open questions and 2 matching questions. In the open questions, students had to fill in what they knew about the domain. For example, students named different materials that balls could be made of. The two matching questions were a good reflection on how well the student knew what balls bounce well on different surfaces. The students had to make a choice between 'bounces well' and 'does not bounce well' for eleven types of balls and ten types of surfaces. The grading of the test was especially useful for evaluating the knowledge students had in advance, and for comparing the scores of the pretest and posttest. The reliability of the pretest as measured with Cronbach's α was .41. A low reliability indicates low internal consistency. This result is not surprising, because of the fact that each question addressed a different construct of the same domain. Because of the low reliability score, an inter-rater reliability test was added. The inter-rater reliability score for the pretest, as measured with Cohen's κ, was .69.

Posttest: The posttest consisted of two parts. The first part contained the same questions as the pretest and could therefore be compared. The second part consisted of three evaluating questions. For example, students had to state which part of the activity they liked best. Since the questions from the second part did not relate to the domain-related knowledge acquired in the lesson, these answers have not been taken into account when the scores of both tests were compared. This was decided upon after the test was created. The reliability of the posttest as measured with Cronbach's α was .28. The inter-rater reliability score for the posttest, as measured with Cohen's κ, was .75.

Results

Flow

A one-way between-groups analysis of variance was conducted to explore the impact of the three different conditions on flow, as measured with the Flow Short Scale of Rheinberger et al. (2003). There were no significant differences for flow between the conditions: F (2, 90) = .35, p = .70.=, partial eta squared = .00. The scores for flow can be found in Table 2. Since flow was not measured in one school, the number of participants was lower for flow than for other measures.

Table 2: Flow scores for the open, guided, and structured condition.

	Open condition n = 30		Guided condition n = 31		Structured condition n = 32		Total n = 93	
Flow scores (Max. 126)	M	SD	M	SD	M	SD	M	SD
	85.93	31.19	80.65	25.27	86.00	30.00	84.19	28.72

Mood

A repeated measure with analysis of variance was conducted to assess the impact of the three different conditions on participants' scores on mood, as measured with the smiley-o-meter of Read (2008). Overall there was a main effect for time, Wilks' Lambda = .71, F (5, 67) = 5.48, p < 001, partial eta squared = .29. This means that the mood scores differed significantly for the different phases of the inquiry cycle. These different mean scores can be found in Table 3. Pairwise comparisons using the Bonferroni method on mean scores for all conditions combined shows that the mean score for the Investigation phase (M = 4.04, SD = .12) was significantly higher than the mean scores for other phases in the inquiry cycle. This means that students in all conditions experienced a more positive mood in the Investigation phase. The main effect comparing the three conditions was not significant, F (2, 71) = .011, p = .99, partial eta squared = .00, suggesting no differences between the three different conditions regarding mood. The different mean scores per condition can be found in Table 3. There was no significant interaction between condition and time, Wilks' Lambda = .84, F (10, 134) = 1.22, p = .28, partial eta squared = .08. Results from participants who did not self-report their mood in

every phase were not analyzed, explaining the lower amount of participants in the guided and structured condition.

Table 3: Mood scores for the open, guided, and structured condition after each phase of the inquiry cycle.

	Open condition n = 30		Guided condition n = 22		Structured condition n = 22		Total n = 74	
Phase of the inquiry cycle	M	SD	M	SD	M	SD	M	SD
Orientation	3.77	1.07	3.68	0.84	3.55	0.74	3.67	0.88
Conceptualization	3.53	0.90	3.82	0.96	3.55	1.18	3.63	1.01
Preparation	3.70	1.09	3.95	1.13	4.00	0.93	3.88	1.05
Investigation	3.93	0.98	4.14	1.08	4.05	1.05	4.04	1.04
Conclusion	3.73	1.02	3.36	0.90	3.68	1.17	3.59	1.03
Presentation	3.83	1.05	3.68	1.09	3.64	0.95	3.71	1.03
Total	3.75	1.02	3.77	1.00	3.75	1.00	3.76	1.01

Learning outcomes

A repeated measure with analysis of variance was conducted to assess the impact of three different conditions on participants' scores on the domain-related pretest and posttest, across two time periods (at the start of session one and at the end of session two). The scores for the pretest and posttest can be found in Table 4. Overall, there was a main effect for time, Wilks' Lambda = .94, F (1, 61) = 111, p <.001, partial eta squared = .58. The main effect comparing the three conditions was not significant, F (2, 79) = 12.45, p = .56, partial eta squared = .02, suggesting no difference in the effectiveness of the three different conditions on the learning outcomes of students. There was no significant interaction between condition and time, Wilks' Lambda = .42, F (1, 79) = 1.04, p = .36, partial eta squared = .03. Results from participants who did not complete all assignments on the pretest and posttest were not analyzed, explaining the varying amount of participants for all conditions.

Table 4: Domain-related learning outcomes for the open, guided, and structured condition for the pretest and posttest.

	Open condition n = 27		Guided condition n = 26		Structured condition n = 29		Total n = 82	
	M	SD	M	SD	M	SD	M	SD
Pretest (Max. 46)	24.56	2.12	24.65	2.81	24.48	2.91	24.56	2.61
Posttest (Max. 46)	27.33	2.53	28.35	1.94	27.28	3.31	27.65	2.59

Discussion

The aim of this study was to measure the differences in mood, flow, and learning outcomes for three different types of inquiry based learning for high-ability students. These three types were open inquiry, guided inquiry, and structured inquiry, following the theory of Banchi and Bell (2008). Open inquiry was expected to generate the most positive mood throughout the different phases, since students are able to conduct their research according to their own interests and abilities. Guided inquiry was expected to generate the highest level of flow, since students work towards a clear goal but will also most likely experience an optimal balance between perceived challenges and skills. Guided inquiry was also expected to create the highest increase in learning outcomes since students experience some structure on how to perform the assignments, but also certain degrees of freedom to alter the research to their own abilities and interests.

The results for flow were not significant, indicating that students' flow experience did not differ among the different conditions. This is an unexpected result, since the different conditions did not all contain the same set of goals and challenges (Csikszentmihalyi, 2014; Csikszentmihalyi et al., 2014). The scores for flow in all conditions were high when compared to the maximum score, indicating that students in all conditions experienced flow. An explanation for this could be that the structure that was presented in all conditions served as a clear set of goals for students, as this causes flow (Csikszentmihalyi, 2014). In addition, students in all conditions could have experienced the tasks presented as challenging enough according to their skills, as this causes flow as well (Csikszentmihalyi et al., 2014).

The scores for mood did not differ significantly among the different conditions, indicating that students in all conditions experienced an equally positive mood throughout the learning activity. This is an unexpected result, since students' mood is likely to improve when students are allowed to choose activities within their own area of interest (Phillips & Lindsay, 2006; Moeed, 2015). This would have been more present in open and guided inquiry than in structured inquiry. As for open inquiry, due to the greatest extent of choices they had to design the research according to their own interests, students were expected to express a more positive mood than guided inquiry and structured inquiry (Moeed, 2015). However, if the domain they had to execute their research in did not interest them and thus limited their choices, this statement does not apply. An explanation for the similar scores in the guided and structured condition can be found in the experience of choice that students had. If students in the guided and structured condition experienced an equal amount of choice to complete activities according to their own interest, they will most likely express an equally positive mood (Phillips and Lindsay, 2006; Jones et al., 2015).

Students in the open and guided condition could have also felt an equal amount of choice to plan and design their research according to their own interests as students in the structured condition. Consequently, students in all conditions expressed an equally positive mood throughout the first three phases of the inquiry cycle (Orientation, Conceptualization, and Preparation). In the Investigation phase, however, a notable significant difference was found. Students in all conditions expressed a more positive mood in this phase than in any other phase of the inquiry cycle. This is an expected outcome, since students experience a positive mood when actively conducting their research and perform actions to generate answers to their questions (Jones et al., 2015). Overall, the scores for mood do not drop below 3, indicating that students do not experience any negative feelings when completing the assignments. This shows that inquiry based learning is indeed a motivating instructional strategy that could be offered to high-ability students.

As for learning outcomes, there was a main effect for time for all three conditions. This means that students in all three conditions improved their learning results from the pretest to the posttest. This could be due to the fact that the inquiry learning activity contained information students could use while answering questions on the posttest.

There were no significant differences between conditions for learning outcomes. This means that there was an equal improvement of learning outcomes among conditions. The lack of information and given answers in the open condition did not lead to any problems for the students. This result contradicts with the statement of Woods-McConney et al (2016), who state that students first need to know what inquiry based learning is before this enhances their learning outcomes, but matches with the statement of Kettler (2014), who says that high-ability students are able to learn with minimal instruction. Apparently, the structure that was presented to students in the open condition offered enough possibilities for students to learn and develop knowledge (Phillips & Lindsay, 2006). In contrast, the amount of information and given answers that was given to a greater extent in the guided and structured condition did not seem to support or bother these students, and thus did not result in significant differences for learning outcomes among conditions. Overall, it can be said that the improvement of learning outcomes of high-ability students did not depend on the amount of information and support that distinguished the three different types of inquiry learning.

Since students in this study were unexperienced with inquiry based learning, an explanation for the high scores in flow, mood, and learning outcomes can be found in the novelty effect. Students were presented with a new kind of learning which may have led to higher scores for mood than it would have for students who were already familiar with inquiry based learning. Besides, inquiry learning itself could have been challenging for unexperienced high-ability students, which would explain the high scores for flow. The high scores for mood and flow might have also led to high scores for learning outcomes. The differences for learning outcomes between conditions were not significant, but students in each condition improved their learning outcomes score over time, meaning that students in all conditions were able to learn during both sessions. An explanation for the fact that all conditions improved their scores might be that high-ability students are used to perform well without instruction or background information (Kettler, 2014). The structure that was provided in all conditions could have offered enough support for high-ability students.

An important limitation of this research is the low reliability score for the pretest and posttest that was used to measure learning outcomes. In this study, the short pretest and posttest included only a few questions to cover the different constructs of the

domain. A way to improve this is to generate a test with more items covering the different constructs of the domain, which consequently will lead to a higher reliability score. When conducting a similar research, it is important to create a pretest and posttest with more reliability which creates results that can be used with more certainty.

Conclusion

Based on the needs and characteristics of high-ability students, inquiry learning seems to be a good instructional strategy. The results of this study support this statement since all three types of inquiry learning lead to high scores for mood, flow, and learning outcomes. In this study, students expressed a positive mood showed in all conditions, which might have led to a similar increase in learning outcomes for all conditions. Moreover, students' ongoing positive mood for the task could have led to the experience of flow. In this study, the levels of flow experienced by students were high when compared to the maximum score. High scores for mood and flow indicate that high-ability students have a positive attitude towards the activities presented in this study, which could lead to high learning outcomes. Overall, the results of this study contribute to the conclusion that inquiry based learning can be an instructional strategy that generates a positive mood, an experience of flow, and an improvement of learning outcomes for high-ability students in pull-out classes.

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Appendices

Leerlingnummers:

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Appendix 1: Worksheet open inquiry

Werkblad

Stap 1: Verwonderen

Beantwoord de vragen hieronder in tweetallen. Soms moet je een voorspelling doen; soms geef je achteraf antwoord op een vraag. Kijk hier goed naar en denk goed mee!

Vraag 1*: voorspellen*: Welke bal stuitert hoger, denk je?

_____

Vraag 2: Welke bal stuitert hoger?

_____

Vraag 3: Klopt dit met wat je van tevoren dacht?

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Vraag 4: *voorspellen*: Wat zal er gebeuren als je de ballen op elkaar laat vallen?

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Vraag 5: Hoe komt dit, denk je?

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Vraag 6: Net hebben jullie klassikaal een proefje gedaan. Wat ben je nu te weten gekomen?

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Vraag 7: Welke vragen zou je zelf graag willen onderzoeken met deze materialen?

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Stap 2: Verkennen

Net hebben jullie klassikaal een proefje gedaan. Maar wat weten jullie nog meer over het onderwerp? Schrijf hieronder zoveel mogelijk dingen op die met de stuiterhoogte van ballen te maken hebben.

Welke van bovenstaande onderdelen zou je graag willen onderzoeken?

_____

Probeer hieronder een mooie onderzoeksvraag te maken. Houd hierbij rekening met onderstaande punten:

1. Het moet een onderzoeksvraag zijn, niet iets dat je kunt opzoeken.

2. Je kunt maar 1 ding tegelijk onderzoeken.

3. Omschrijf precies genoeg wat je wilt onderzoeken

4. Houd er rekening mee dat je het zelf moet uitvoeren, binnen ongeveer 20 minuten.

De vraag:

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Stap 3: Onderzoek opzetten

Onze onderzoeksvraag is:

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We denken dat dit het antwoord zal zijn op onze vraag:

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De volgende stappen gaan we nemen tijdens ons onderzoek:

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De volgende dingen gaan we vergelijken:

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Zo schrijven we tijdens het onderzoek op wat we te weten komen:

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De volgende materialen hebben we nodig:

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Dit moeten we nog regelen voor we met ons onderzoek kunnen starten:

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De taken tijdens de voorbereiding en uitvoering van ons onderzoek verdelen we op de volgende manier:

Naam	Taak	Datum wanneer het af is

Leerlingnummers:

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Stap 4: Onderzoek uitvoeren – resultaten

Hier vullen jullie in wat jullie tijdens het onderzoek ontdekt hebben. Probeer zo goed mogelijk te beschrijven wat er gebeurde en wat jullie gezien hebben.

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Verwachtingen:

Kloppen de resultaten met wat jullie van tevoren verwacht hadden? Dit kun je terugvinden op jullie onderzoeksplan.

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Stap 5: Concluderen

Hier vullen jullie in wat het antwoord op jullie onderzoeksvraag is. Dit doen jullie door nog eens naar de resultaten te kijken en te bedenken hoe dit kan. Waarom is er gebeurd wat er is gebeurd?

Hebben jullie alles uitgevoerd zoals jullie het bedacht hadden? Waarom wel of niet? Kan dit invloed hebben op het uiteindelijke antwoord?

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Stap 6: Presenteren

Dit hebben we nodig voor onze presentatie:

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Dit willen we (in het kort) vertellen tijdens onze presentatie:

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Leerlingnummers:

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Appendix 2: Worksheet guided inquiry

Werkblad

Stap 1: Verwonderen

Beantwoord de vragen hieronder in tweetallen. Soms moet je een voorspelling doen; soms geef je achteraf antwoord op een vraag. Kijk hier goed naar en denk goed mee!

Vraag 1*: voorspellen*: Welke bal stuitert hoger, denk je?

_____

Vraag 2: Welke bal stuitert hoger?

_____

Vraag 3: Klopt dit met wat je van tevoren dacht?

_____

Vraag 4: *voorspellen*: Wat zal er gebeuren als je de ballen op elkaar laat vallen?

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Vraag 5: Hoe komt dit, denk je?

_____

Vraag 6: Net hebben jullie klassikaal een proefje gedaan. Wat ben je nu te weten gekomen?

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Vraag 7: Welke vragen zou je nog meer kunnen onderzoeken met deze materialen?

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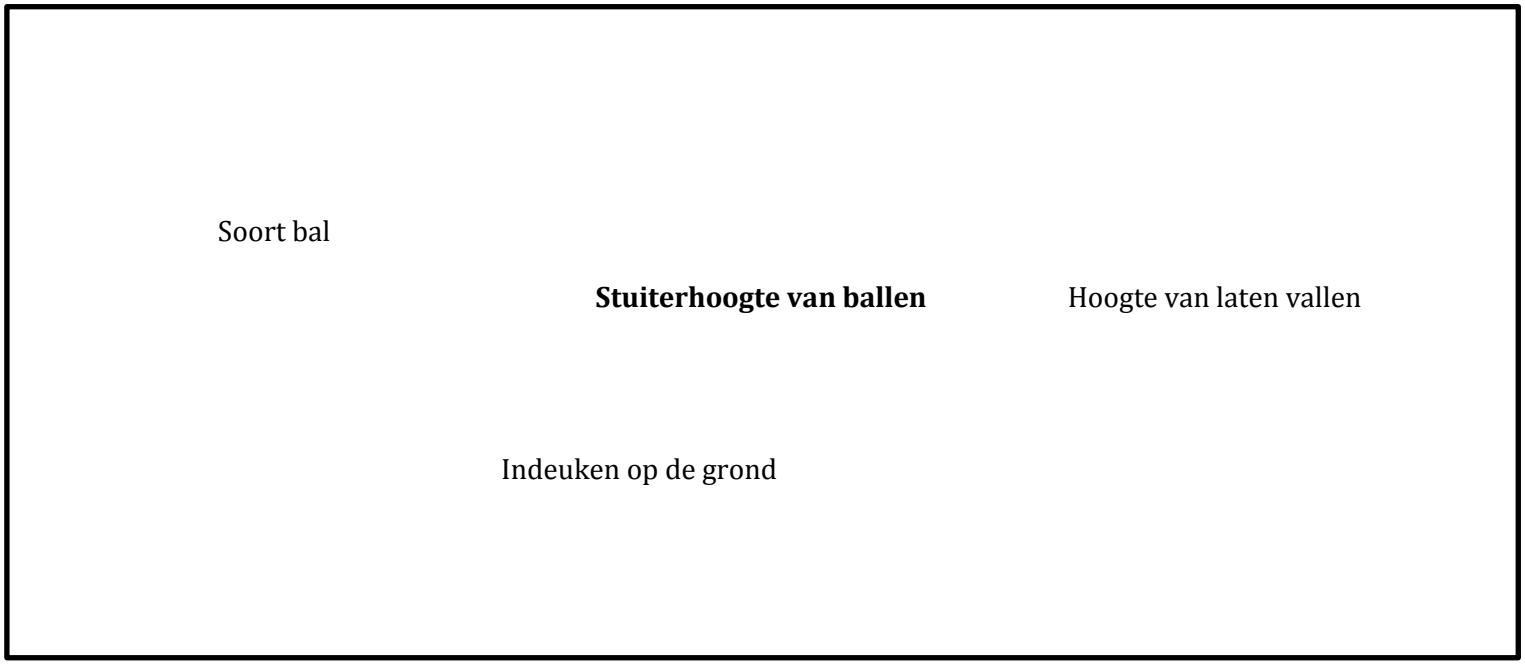
Stap 2: Verkennen

In onderstaande mindmap vind je een aantal dingen die te maken hebben met de stuiterhoogte van ballen. Vul deze mindmap aan met je eigen ideeën – waar heeft de stuiterhoogte van een bal nog meer mee te maken?



Omdat je niet alles tegelijk kunt onderzoeken, gaan we tijdens deze les 1 onderzoeksvraag behandelen. De onderzoeksvraag moet aan een aantal dingen voldoen, namelijk;

1. Het moet een onderzoeksvraag zijn, niet iets dat je kunt opzoeken.

2. Je kunt maar 1 ding tegelijk onderzoeken.

3. Omschrijf precies genoeg wat je wilt onderzoeken

4. Houd er rekening mee dat je het zelf moet uitvoeren, binnen ongeveer 20 minuten.

De onderzoeksvraag die jullie deze les gaan behandelen, is deze:

<u>Wat bepaalt de stuiterhoogte van een bal?</u>

Deze vraag delen we op in drie kleinere vragen:

1. Wanneer stuitert een bal het hoogst; als deze gemaakt is van leer of van rubber?
2. Wanneer stuitert een bal het hoogst; op zand, op steen of op hout?
3. Wanneer stuitert een bal het hoogst; als je deze van een halve meter of van 1 meter naar beneden laat vallen?

Deze vragen voldoen aan alle vier de eisen, en zijn dus klaar om onderzocht te worden! Hoe je dit moet doen, lees je in stap 3: Onderzoek opzetten, op de volgende bladzijden.

Stap 3: Onderzoek opzetten

Onze onderzoeksvraag is:

Wat bepaalt de stuiterhoogte van een bal?
1. Wanneer stuitert een bal het hoogst; als deze gemaakt is van leer of van rubber?
2. Wanneer stuitert een bal het hoogst; op zand, op steen of op hout?
3. Wanneer stuitert een bal het hoogst; als je deze van een halve meter of van 1 meter naar beneden laat vallen?

We denken dat dit het antwoord zal zijn op de drie vragen hierboven:

1. .....

2. .....

3. .....

De volgende stappen gaan we nemen tijdens ons onderzoek:

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De volgende dingen gaan we vergelijken:

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Zo schrijven we tijdens het onderzoek op wat we te weten komen:

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De volgende materialen hebben we nodig:

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Dit moeten we nog regelen voor we met ons onderzoek kunnen starten:

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De taken tijdens de voorbereiding en uitvoering van ons onderzoek verdelen we op de volgende manier:

Naam	Taak	Datum wanneer het af is

Leerlingnummers:

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Stap 4: Onderzoek uitvoeren - resultaten

Hier vullen jullie in wat jullie tijdens het onderzoek gemeten en geobserveerd hebben. Probeer zo duidelijk mogelijk te beschrijven wat er gebeurde en hoe jullie denken dat dit kan.

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Verwachtingen:

Kloppen de resultaten met wat jullie van tevoren verwacht hadden? Dit kun je terugvinden op jullie onderzoeksplan.

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Stap 5: Concluderen

Hier vullen jullie in wat het antwoord op jullie onderzoeksvraag is. Dit doen jullie door nog eens naar de resultaten te kijken en hiervoor een verklaring te bedenken. Ook kijken jullie nog eens terug naar het onderzoeksplan, hebben jullie alles uitgevoerd zoals jullie het bedacht hadden? Waarom wel of niet? Kan dit invloed hebben op het uiteindelijke antwoord?

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Stap 6: Presenteren

Dit hebben we nodig voor onze presentatie:

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Dit willen we (in het kort) vertellen tijdens onze presentatie:

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Leerlingnummers:

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Appendix 3: Worksheet structured inquiry

Werkblad

Stap 1: Verwonderen

Beantwoord de vragen hieronder in tweetallen. Soms moet je een voorspelling doen; soms geef je achteraf antwoord op een vraag. Kijk hier goed naar en denk goed mee!

Vraag 1*: voorspellen*: Welke bal stuitert hoger, denk je?

_____

Vraag 2: Welke bal stuitert hoger?

_____

Vraag 3: Klopt dit met wat je van tevoren dacht?

_____

Vraag 4: *voorspellen*: Wat zal er gebeuren als je de ballen op elkaar laat vallen?

_____

_____

Vraag 5: Hoe komt dit, denk je?

_____

Vraag 6: Net hebben jullie klassikaal een proefje gedaan. Wat ben je nu te weten gekomen?

_____

_____

_____

Er zijn heel veel dingen die te maken hebben met de stuiterhoogte van ballen. Een aantal dingen vind je op de volgende bladzijde, in de mindmap.

Stap 2: Verkennen

In onderstaande mindmap vind je een aantal dingen die te maken hebben met de stuiterhoogte van ballen. Lees deze goed en vul aan met je eigen ideeën – wat heeft er nog meer mee te maken, denk je?

Materiaal van de bal

Soort bal **Stuiterhoogte van ballen** Hoogte van laten vallen
Laten vallen – met kracht gooien

Zwaartekracht

Vering van de bal Indeuken op de grond

Ondergrond

Omdat je niet alles tegelijk kunt onderzoeken, gaan we tijdens deze les 1 onderzoeksvraag behandelen. De onderzoeksvraag moet aan een aantal dingen voldoen, namelijk;

1. Het moet een onderzoeksvraag zijn, niet iets dat je kunt opzoeken.

2. Je kunt maar 1 ding tegelijk onderzoeken.

3. Omschrijf precies genoeg wat je wilt onderzoeken

4. Houd er rekening mee dat je het zelf moet uitvoeren, binnen ongeveer 20 minuten.

De onderzoeksvraag die jullie deze les gaan behandelen, is deze:

<u>Wat bepaalt de stuiterhoogte van een bal?</u>

Deze vraag delen we op in drie kleinere vragen:

1. Wanneer stuitert een bal het hoogst; als deze gemaakt is van leer of van rubber?
2. Wanneer stuitert een bal het hoogst; op zand, op steen of op hout?
3. Wanneer stuitert een bal het hoogst; als je deze van een halve meter of van 1 meter naar beneden laat vallen?

Deze vragen voldoen aan alle vier de eisen, en zijn dus klaar om onderzocht te worden! Hoe je dit moet doen, lees je in stap 3: Onderzoek opzetten, op de volgende bladzijden.

Stap 3: Onderzoek opzetten

Onze onderzoeksvraag is:

Wat bepaalt de stuiterhoogte van een bal?
1. Wanneer stuitert een bal het hoogst; als deze gemaakt is van leer of van rubber?
2. Wanneer stuitert een bal het hoogst; op zand, op steen of op hout?
3. Wanneer stuitert een bal het hoogst; als je deze van een halve meter of van 1 meter naar beneden laat vallen?

We denken dat dit het antwoord zal zijn op de drie vragen hierboven:

1. .....

2. .....

3. .....

De volgende stappen gaan we nemen tijdens ons onderzoek:

1. Je gaat een leren bal en een rubberen bal met elkaar vergelijken.
2. Dit doe je op een ondergrond van zand, steen en hout.
3. Je laat de leren en de rubberen bal allebei van een halve meter en een hele meter naar beneden vallen. Dit doe je op alle drie de ondergronden met beide ballen. In totaal laat je elke bal dus minstens 6x vallen.

De volgende dingen gaan we vergelijken:

Je vergelijkt voor elke ondergrond en hoogte dezelfde ballen. Zo kun je bepalen welke ondergrond zorgt voor de hoogste stuiter, en ook welke hoogte van laten vallen zorgt voor de hoogste stuiter. Uiteindelijk krijg je antwoord op de vraag wat bepaalt hoe hoog een bal stuitert.

Zo schrijven we tijdens het onderzoek op wat we te weten komen:

.....

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De volgende materialen hebben we nodig:

1 leren bal
1 rubberen bal
ondergrond van zand, steen en hout
1 meetlat

Dit moeten we nog regelen voor we met ons onderzoek kunnen starten:

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De taken tijdens de voorbereiding en uitvoering van ons onderzoek verdelen we op de volgende manier:

Naam	Taak	Datum wanneer het af is

Leerlingnummers:

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Stap 4: Onderzoek uitvoeren - resultaten

Hier vullen jullie in wat jullie tijdens het onderzoek gemeten en geobserveerd hebben. Probeer zo duidelijk mogelijk te beschrijven wat er gebeurde en hoe jullie denken dat dit kan.

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Hypothese:

Kloppen de antwoorden met wat jullie van tevoren verwacht hadden? Dit vind je terug onder stap 3: onderzoek opzetten.

……

……

……

Stap 5: Concluderen

Hier vullen jullie in wat het antwoord op jullie onderzoeksvraag is. Dit doen jullie door nog eens naar de resultaten te kijken en hiervoor een verklaring te bedenken. Ook kijken jullie nog eens terug naar het onderzoeksplan, hebben jullie alles uitgevoerd zoals jullie het bedacht hadden? Waarom wel of niet? Kan dit invloed hebben op het uiteindelijke antwoord?

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.....

Stap 6: Presenteren

Dit hebben we nodig voor onze presentatie:

.....

.....

Dit willen we (in het kort) vertellen tijdens onze presentatie:

.....

.....

.....

Leerlingnummer:

……

Appendix 4: Questionnaire mood: Smiley-o-meter

Werkblad gevoel

Op dit werkblad kruis je steeds aan hoe je je voelt na elke opdracht. Het is belangrijk dat je goed nadenkt over hoe je je voelt, en dat je dit zelfstandig invult.

Na stap 1: verwonderen, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Na stap 2: verkennen, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Na stap 3: onderzoek opzetten, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Leerlingnummer:

……

Werkblad gevoel

Op dit werkblad kruis je steeds aan hoe je je voelt na elke opdracht. Het is belangrijk dat je goed nadenkt over hoe je je voelt, en dat je dit zelfstandig invult.

Na stap 4: onderzoek uitvoeren, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Na stap 5: Concluderen, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Na stap 6: Presenteren, voel ik me:

Slecht	Niet heel goed	Goed	Heel goed	Super

Appendix 5: Questionnaire flow: Flow Short Scale

Leerlingnummer:

……

Wat vond je van deze taak?

	Klopt						Klopt niet
Ik vond de opdrachten leuk	1	2	3	4	5	6	7
Ik vond het fijn dat je bij deze opdrachten nieuwe dingen leerde	1	2	3	4	5	6	7
Deze opdrachten vind ik nuttig	1	2	3	4	5	6	7
Ik hoef geen beloning. De opdrachten gaven me plezier genoeg!	1	2	3	4	5	6	7
Deze opdrachten vond ik erg interessant	1	2	3	4	5	6	7
Denken ging makkelijk	1	2	3	4	5	6	7
De juiste gedachten kwamen vanzelf	1	2	3	4	5	6	7
Bij iedere opdracht wist ik wat ik moest doen	1	2	3	4	5	6	7
Ik had het gevoel dat ik alles onder controle had	1	2	3	4	5	6	7

Appendix 6: Learning outcomes pretest

Test voor

Leerlingnummer:

……..……

Vraag 1: Wat weet je over het stuiteren van ballen?
Probeer een zo uitgebreid mogelijk antwoord te geven.

_____

_____

_____

_____

Vraag 2: Wanneer is het handig als een bal hoog stuitert?

_____

_____

_____

_____

Vraag 3: Wat bepaalt hoe hoog een bal stuitert?
Probeer een zo uitgebreid mogelijk antwoord te geven.

_____

_____

_____

_____

Vraag 4: Welk materiaal waarvan ballen gemaakt zijn ken je? Vul ze hieronder in. Je hoeft niet op elke lijn iets in te vullen.

_____

_____

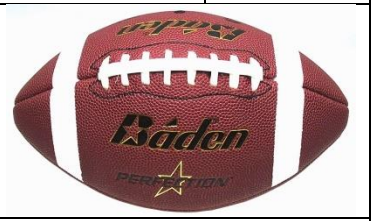
_____

_____

_____

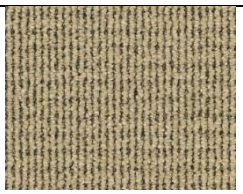
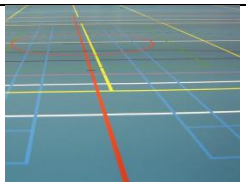
_____

Vraag 5: Welke van deze ballen stuitert goed en welke niet? Zet ze in het juiste rijtje.

					
Pingpongbal	Softbal	Volleybal	Bowlingbal	Tennisbal	Stuiterbal
					
Hockeybal	Basketbal	Voetbal	Golfbal	Rugbybal	

Stuitert goed	Stuitert niet goed
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Vraag 6: Welke ondergrond zorgt voor een goede stuiter en welke niet? Zet ze in het juiste rijtje.

				
Zand	Steen	Gras	Hout	Vloerbedekking
				
Water	Rubber	Asfalt	Grind	Linoleum

Stuitert goed	Stuitert niet goed
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Vraag 7: Wanneer stuitert een bal het hoogst? Noem in ieder geval het materiaal en de ondergrond dat samen zorgt voor de hoogste stuiter.

_____

_____

Appendix 7: Learning outcomes posttest

Leerlingnummer:

……

Test na

Vraag 1: Wat weet je over het stuiteren van ballen?
Probeer een zo uitgebreid mogelijk antwoord te geven.

_____

_____

_____

_____

Vraag 2: Wanneer is het handig als een bal hoog stuitert?

_____

_____

_____

_____

Vraag 3: Wat bepaalt hoe hoog een bal stuitert?
Probeer een zo uitgebreid mogelijk antwoord te geven.

_____

_____

_____

_____

Vraag 4: Welk materiaal waarvan ballen gemaakt zijn ken je? Vul ze hieronder in. Je hoeft niet op elke lijn iets in te vullen.

_____

_____

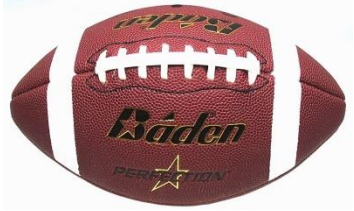
_____

_____

_____

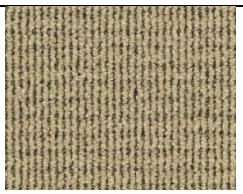
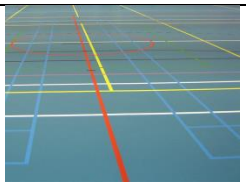
_____

Vraag 5: Welke van deze ballen stuitert goed en welke niet? Zet ze in het juiste rijtje.

					
1. Pingpongbal	2. Softbal	3. Volleybal	4. Bowlingbal	5. Tennisbal	6. Stuiterbal
					
7. Hockeybal	8. Basketbal	9. Voetbal	10. Golfbal	11. Rugbybal	

Stuitert goed	Stuitert niet goed
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Vraag 6: Welke ondergrond zorgt voor een goede stuiter en welke niet? Zet ze in het juiste rijtje.

				
1. Zand	2. Steen	3. Gras	4. Hout	5. Vloerbedekking
				
6. Water	7. Rubber	8. Asfalt	9. Grind	10. Linoleum

Stuitert goed	Stuitert niet goed
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Vraag 7: Wanneer stuitert een bal het hoogst? Noem in ieder geval het materiaal en de ondergrond dat samen zorgt voor de hoogste stuiter.

_____

_____

_____

Vraag 8: Wat is de belangrijkste ontdekking die je tijdens deze les hebt gedaan?

_____

_____

_____

Vraag 9: Heb je iets nieuws geleerd tijdens deze les?

- Nee
- Ja, namelijk:

_____

_____

_____

Vraag 10: Welk onderdeel van de les vond je het leukst?

_____

_____

_____