

**Long Term Impact of Professional Development Program on Teachers to Address
Diversity in Science Classrooms**

Supervisor: Dr Michiel Doorman

Lopamudra Das (6456162)

ECTS: 30

Utrecht University

Abstract

Due to globalization, schools are becoming increasingly multicultural. This issue leads to new challenges for teachers to give instruction in a diverse class. In order to effectively provide teaching in diverse classrooms, teachers should understand the cultural differences of students, and at the same time combine a variety of professional teaching techniques based on inquiry-based learning on a long-term basis (Naff & Hope, 2017). This research investigates the factors that influence the long-term impact of professional development (PD) course while practicing inquiry-based learning in diverse science classrooms. Furthermore, the research was carried out to find the reasons behind the hindrance in practicing the elements of the professional development course and to know the ways for the further improvement of the course. Semi-structured interviews were performed with three case study teachers (two from the Netherlands and one from Cyprus), and questionnaires were filled in by 26 teachers from all six European countries who participated in a previous professional development course. Questionnaires and interviews were used to explore the long-term effect of professional development course on teachers. The results suggest a positive and long-term impact on teachers towards implementing IBL related teaching techniques in their class for inclusive science education . However, the lack of time and the absence of support from school management emerged as two key factors in the hindrance of implementing such teaching techniques. In conclusion, based on the teachers' recommendations, the online networking aspect of teachers, the collaboration & interaction between colleagues, and networking during the PD session have emerged as the important elements for further improvement of PD courses oriented on inclusive science education.

Table of Contents

ABSTRACT	2
1.INTRODUCTION.....	4
2.THEORETICAL FRAMEWORK.....	5
2.1. INQUIRY-BASED LEARNING AND DIVERSITY.....	5
2.2. TEACHER’S CHANGE IN PRACTICE AND PROFESSIONAL DEVELOPMENT PROGRAM.....	7
2.3. EFFECTIVENESS OF TEACHER’S PROFESSIONAL DEVELOPMENT.....	8
2.4. CONTEXT OF THE RESEARCH: (MASDIV’S PD-COURSE AND SHORT-TERM EVALUATION)	9
3. RESEARCH QUESTION	10
4.METHOD.....	10
4.1. PARTICIPANTS.....	11
4.2. DESIGN OF INSTRUMENTS	11
4.2.1 <i>Designing the instruments for interview Questions</i>	11
4.2.2. <i>Designing the instruments for questionnaire (Google-doc)</i>	12
4.2.3. <i>Data Analysis</i>	13
5.RESULTS.....	16
5.1. <i>Topic: Inquiry based learning in diversity</i>	16
5.2. <i>Topic: Reason behind the hindrance of implementation</i>	19
5.3. <i>Topic: Recommendation for the further improvement</i>	21
6.DISCUSSION, LIMITATION AND RECOMMENDATION	22
9.REFERENCES.....	25
APPENDIX-1: TEACHER INTERVIEW	27
APPENDIX-2: GUIDELINE FOR INTERVIEW	29
APPENDIX-3: TEACHER QUESTIONNAIRE.....	30
APPENDIX-4: TEACHER QUESTIONNAIRE - ITEM SCALE DOCUMENTATION.....	33
APPENDIX-5: INTERVIEW CODING	35
APPENDIX-6: TEACHER CONSENT FORM.....	38
APPENDIX-7: TEACHER-PROJECTS.....	39

1.Introduction

In our current well-developed society still millions of young people are not employed and are less involved in social and political life (European Commission¹, 2007). Their inability to participate in a quickly changing and highly technical society is the primary reason behind the unemployability. In order for students to stand out in society, they need to be equipped with the 21st-century skills through STEM education. When there is insufficient interest in STEM, students who want to choose a STEM profession will have a greater risk of success (Rogers², 2009). A strong emphasis in Europe is placed on STEM (Science, Technology, Engineering and Mathematics). In addition to that science education must enable students to participate actively in society according to the Paris declaration (Eurydice, 2016). It also requires creating one inclusive education system that values all students to create a classroom within the mainstream school systems that respect diversity. Hence, to identify and reduce the barriers to inclusion and increase the participation in learning, the index of inclusion supports the creation of an inclusive culture for all students (Vaughan, 2002).

The key mediator in science education is teacher. Concerningly, many teachers in the lower secondary have expressed their urgency on how to teach their students in accordance to their different achievement levels and cultures (Eurydice³, 2015). Inquiry-Based Learning (IBL) seems to be the best option to solve this as it promotes student learning, and the development of different achievement levels in self-learning and it stimulates self-learning and discovery of new knowledge (Engeln et al., 2013). In IBL teaching practice, teachers roam among the students, listening to them and guiding them with necessary questions and motivate the students to engage in classroom activities. Teachers assist the management of questioning and thinking skills of students as well as providing collaborative learning by motivating them to work in groups. Additionally, IBL engages students at different ability levels; allowing them to work at their own pace while giving the chance for all students to reach mastery on the basis of their performance (Crawford, 2000).

Furthermore, an inclusive education promotes the learning of all students by integrating the IBL (Inquiry based learning) approach through the engagement of students at different ability levels in a diverse class (Vaughan, 2002). This diversity creates challenges for teachers to change the structure and assessment of the curriculum taking into account the needs of all students. Also, teachers may view students through the experiences they have developed throughout their teaching experience. This experience may not accurately reflect an understanding of cultural differences in a diverse class. Hence, a lot of teachers do not see the need for changing their teaching practice (Naff & Hope, 2017). The major reason why teachers do not change their teaching seems to be a lack of professional development (PD) providing reasons why and showing examples how to change their practices (Capps et al., 2012).

¹ https://ec.europa.eu/education/policies/school/key-competences-and-basic-skills_en

² <http://iweb.tntech.edu/rpl/rapidtech2009/rogers.pdf>

³ <https://www.csee-etuice.org/en/news/archive/1421-new-%20eurydice-report-on-paris-declaration-developments-in-national-education-policies>

To develop and support professional development for addressing diversity with IBL in science education, recent EU-supported initiatives, like the project Masdiv⁴, has been launched. In the Masdiv project, teachers from Cyprus, Germany, Malta, Netherlands, Turkey and Spain participated in a professional development (PD) course about inquiry-based learning in addressing diversity in science classes.

In the Netherlands, Masdiv professional development (PD) activities included the participation of teachers in two PD courses during spring 2018. Each course consisted of four sessions of three hours with practice-related homework between the sessions. In one course mainly, experienced teachers (the U-talent group) participated, and the other aimed at starting teachers (the Utrecht university group). Four meetings were performed with the teachers which addressed the IBL related subjects like 1) designing and implementing inquiry-based lessons 2) diversity in the teacher's classes 3) how to deal with the problems within the classroom examining and reflecting upon PD session practices.

The diverse IBL initiative was successful in the short term (based on evaluation report of Masdiv Pd course⁵). The results from the evaluation of Masdiv shows that teachers' self-efficacy beliefs regarding the use of IBL to address achievement-related diversity ($d = .26, p < .001$), the use of contexts ($d = .39, p < .001$) and addressing cultural diversity ($d = .38, p < .001$) all improved significantly. Teachers in the Netherlands reported an increased level of student engagement when using IBL methods in the classroom. Also, they point out the enhancement of their knowledge and beliefs on inquiry-based lessons. Most of the teachers supported that their beliefs and teaching practices changed which was also confirmed by student's engagement in class.

However, Masdiv's professional developmental course was implemented for more than a year. There haven't been any follow-ups done after the implementation to see whether this inquiry-based professional development course has long term impact on teachers or not. In this Masdiv follow-up research, it will be investigated whether the change of their beliefs and experiences has an impact on their practices. Investigating these aspects will help to gain insights into the long-term effect of professional development course on teachers' use of IBL to take the opportunity of diversity in their classroom practices.

2.Theoretical framework

2.1. Inquiry-based learning and Diversity

In Inquiry-Based Learning (IBL) is a student-centered teaching approach with the aim to involve students in phases of inquiry. This approach requires new tasks and new teaching procedures and a constant teacher-students interaction. The role of the teacher is essential for this type of learning because teachers need to balance between giving students initiative in inquiry and guiding the whole class learning progress. In the traditional methods, the class is oriented around the teacher's perspective, hence limiting the student's performance. Whereas, in IBL-teacher facilitates the learning process by monitoring and modeling the student's performance in class (Maass, 2011).

⁴ <https://icse.eu/international-projects/masdiv/>

⁵ https://icse.eu/wp-content/uploads/2018/SonstigePDFs/MaSDiV_D5.1_WP5_Evaluation-Report.pdf

However, IBL seems rather successful yet hard to implement. Also, it is difficult for teachers who are not experienced with IBL or who are trying to implement IBL in their day-to-day teaching after a short introduction of IBL. Because these short term experience in IBL don't usually give teachers concrete content that they can take back directly to their classrooms. In addition, the implementation of IBL also requires a lot of time and resource planning. In the diverse settings, the problem is even more complicated as teachers have to communicate with students of different ethnicity, sexual orientation, gender, socio-economic status, etc (Engeln et al., 2013). Teachers need to be aware of the different expectations of the diverse class to implement inquiry-based learning. The culture may be the most important dimension that presents a problem for teachers in implementing new approaches. The teacher has to recognize the cultural needs of a diverse student population. Classroom instructions has to be modified in alignment with the individual student need. It should be implemented in such a way that it will not create any difficulty in the way of learning (Crawford, 2000).

For effective implementation, teachers allow the differentiated approach for the adaption of curriculum, teaching practices and learning environment in a diverse class (Larina & Markina, 2019). In every class there is a disparity in the student's level, prior knowledge, interests, and abilities. This issue is mitigated through differentiated classroom teaching; which aims to increase motivation and skills of the students. Differentiated instructions allow students to be self-directed, creative and have investigative knowledge by using basic concepts and principles. Student's prior knowledge, culture, learning preferences, and interests are taken into account while practicing a differentiated approach. The study by Larina & Markina (2019) describes two models (i.e. exclusive and inclusive model) for the differentiation approach. In the exclusive model, differentiation is based on the teacher's belief on student's performance in class. The teacher labels the students to normal, strong and weak based on their abilities, interest in subject and motivation to learn. In an inclusive model, teacher's belief based on the possibility of developing abilities of students regardless of their interest or performance in the subject. In both of these models, the teacher's belief is based on the assessment of student's abilities which affects the student's learning capacities. Hence, while addressing cultural dimension in a diverse class, if teachers are supported by personal development courses to enhance or change their beliefs and practices, these changes eventually promote student achievement (Capps et al., 2012).

For this study, we have focused on beliefs related to teachers' adequate knowledge of inquiry-based learning and willingness towards inquiry-based learning and teaching. Also, research shows that the teacher's belief can help to identify its effect on teacher's long-term practice of IBL in the classroom (Chapman & Heater, 2010). The understanding of teachers' learning activities and learning outcomes are associated with changes in knowledge and beliefs, emotions, practices and intentions for practice. Over time, the teacher will develop in-depth knowledge and understanding on inquiry and learning by deepening their views and holding beliefs. In addition to that, the model by Guskey (2002) showed that a substantial change occurs in the beliefs and attitudes of teachers after receiving evidence of improvement in student's learning.

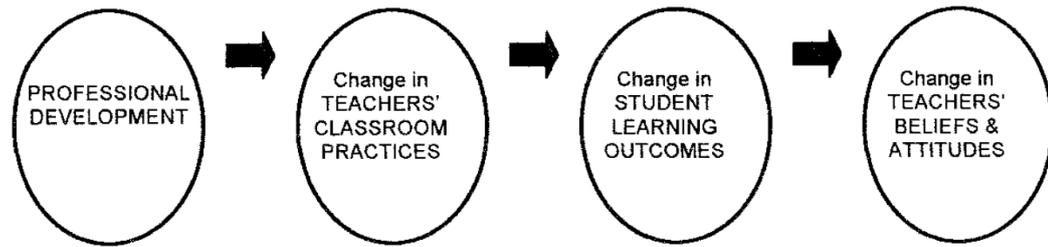


Figure 1. A-model of teacher's change (Guskey,2002, P.383)

2.2. Teacher's change in practice and professional development program

Change in a teacher's practice occurs when the teacher can change their personal experience (Chapman & Heater, 2010). In this study teacher's change refers to change in teaching behavior as reflected in teaching practice and to change their beliefs. Consequently, the changes occur due to new instructional and innovative approaches from the teacher's classroom practice. Examples of the new approaches could be new material, curriculum, or a teacher procedure. Hence, professional development (PD) is necessary for incorporating these new techniques into the classroom teaching practice. Based on the findings of this study, there are both positive and negative attitudes towards the effectiveness of PD. It highlights three types of changes towards PD which are: Conceptual change, Instrumental change, and foundational change are three professional developmental opportunities for the teachers in accordance to their level of engagement. Instrumental change is to find out new techniques to use in the classroom. Conceptual change accelerates the teacher's understanding. Foundation change is the way of learning in which teacher's own knowledge and experience could be effective in their learning process.

As per Caps et al. (2012), in order to succeed, the teacher must be a learner, which can be achieved through the ongoing PD-course. Through lifelong learning, not only can teachers be encouraged to develop skills and improve classroom success rates, but they can also better understand curriculum development or the latest research results of the discipline. It is essential for investigating the needs of PD course teachers, their belief in PD, and their future development, with the aim of making PD courses more successful. In addition, it is necessary to consider the context of cultural diversity and achievement diversity as they are the two main elements of this study. In future PD sessions, teachers' expectations, beliefs, and needs should take into account different levels of experience and discipline may affect the results. As demonstrated by the research by Caps et al. (2012) compared with teachers in other disciplines, science teachers are more interested to update their subject knowledge.

However, teachers need to be motivated before changing their beliefs and understanding. Moreover, the teacher's motivation is significantly linked to the student's learning outcomes. Workload and challenges in class, learning materials, remuneration, and incentives are extrinsic components for teacher's motivation, whereas career development (PD-training courses), personal experience are the intrinsic components for teacher's motivation (Guajardo, 2011). Different types of factors, with highly diverse experiences and consequences, can have an influence on people to change their motivation. It has been found that teachers' extrinsic motivation can be transformed into intrinsic motivation (Ryan & Deci, 2000). Teachers' existing value, teaching practice, teachers' experiences, key events influence

intrinsic motivation. Therefore, a PD-course with homework related to practice may affect motivation, which in turn affects its teaching practice and beliefs.

For the effective professional development to occur, it needs to be situated in settings that emphasize teachers' knowledge of the subject and its successful implementation. Clarke and Hollingsworth (2002) indicated four domains for teacher's effective professional growth. Those domains are described as following: personal domain of teachers (knowledge, belief, attitude), the domain of teaching practice, the domain of outcomes and consequences and the external domains such as support and information. According to the same literature, usually all four domains are involved in a teacher's professional development.

2.3. Effectiveness of Teacher's professional development

The professional development of teachers is the process of teachers enhancing their knowledge, understanding, recognition of 'learning how to learn' and transforming their own knowledge into the practice for student's own beneficial growth.

Various findings have demonstrated that well-designed PD courses are capable of improving the beliefs and attitudes of teachers about implementing. Empirical research on PD in the implementation of IBL in science education by Capps et al. (2012). Total time, extended support, real experience, coherence, learning development, modeling, reflection, transfer, and content knowledge are the nine key characteristics of effective PD.

The duration (Total Time) of a PD is recognized as a good indicator of its efficacy. The longer the time invested in active participation and the longer the time covered by PD, the better the effect of PD in long term (Desimone, 2009; Garet et al., 2001). The duration of the PD's focus on IBL is particularly important because participants will need time to understand their own perspectives (beliefs) and reflect on them (reflections). And if a PD expresses the beliefs of teachers in a positive and sensitive way, then they would be able to incorporate IBL in their own classrooms. Another aspect that affects the participation of teachers in a PD is its coherence with the curriculum of the school (Desimone, 2009; Garet et al., 2001).

In addition to focusing on beliefs and attitudes, PD is also committed to helping teachers improve and expand the professional knowledge and skills of IBL. According to Capps et al. (2012, p. 307), teachers "must have an in-depth understanding of science content, fully understand what research is, and experience with both performing scientific investigation and teaching using inquiry-based approaches." Two key approaches can be used to enable teachers to obtain expertise in inquiry processes: engaging teachers in IBL activities (Authentic Experience) or getting them to go through the predefined IBL units (Modeled Inquiry). In order to address the gap between PD course and actual practices, it has proven effective to explore the possibility of using acquired knowledge and changing content (transference) and designing IBL units (develop lessons) (Capps et al., 2012).

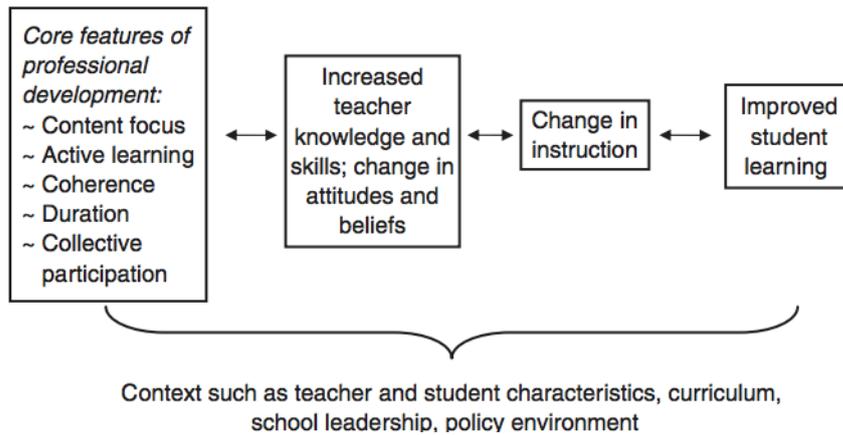


Figure 2. Model showing conceptual framework for studying the effects of professional development on teachers and students (Desimone, 2009, P. 185).

However, besides the above-mentioned supporting factors that positively lead to the effectiveness of PD, many obstructing factors have also been established that may hinder the use of PD for long term practices. Three factors influence the teacher's professional development (based on Saberi & Amiri, 2016). The first issue is management issue related to unfamiliar technology, high costs, and ineffectiveness of school management and teacher's dedicated time to PD. The second one is pedagogical issue, which is related to unclear and context-bound nature of PD, the conflict between teacher's acquired knowledge in professional development and actual classroom practice. The final factor which comes under both management issues and pedagogical issue is personal concern. PD workshops, which underestimate the teacher's thinking and prioritize administration policies fall under this category. The study also shows that schools should invest sufficient funds to provide effective professional development.

2.4. Context of the research: (Masdiv's PD-course and short-term evaluation)

In order to accommodate cultural and socioeconomic performance for mathematics and science teacher, Masdiv, an EU funded project was launched (Masdiv, 2017). Masdiv's project was aimed to develop personal development (PD) courses for teachers' competence to practice inclusive science education for the learning benefit of all students.

Participants in the PD course worked in the following manner:

- Introspection on existing beliefs
- Discussion and provision of concrete subject-specific examples
- Develop and reflect key factors that address diversity in math and science classrooms
- Experimenting with and reflecting on teaching methods for diversity.

Masdiv project had a short-term evaluation to ensure impact of teacher's PD in IBL practice. For evaluation the toolkit used a questionnaire for teachers and one for students, and a case study protocol for following a few of the participating teachers. The case study protocol included an interview schedule for semi-structured interviews and a classroom observation sheet for observing an IBL lesson taught by the teacher.

However, in this research project, there will be a long-term evaluation of the process where the following aspects will be observed:

- Factors influencing teacher's long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course
- Further suggestions for improving PD courses in the future

3. Research Question

The main aim of this research is to investigate if teachers of particular schools who participated in Masdiv before one year, are still practicing IBL in class or not. In order to perform follow-up research for the long term impact, it is important to get a deeper insight into the teacher's beliefs in relation to the implementation of IBL in science classes. In addition, Masdiv's results can be used as a reference for monitoring changes to further improve the course

To investigate the research aim, the following questions have been set for this research:

1. What are the factors that influence teacher's long-term IBL practices for addressing cultural diversity and achievement-related diversity acquired in the Masdiv PD course?
2. What are the reasons behind the hinderance in long term practicing the IBL practices?
3. How can be this PD course be improved to foster long term impact further in the future?

In short, it can be investigated that the research on follow-up Masdiv professional development project will demonstrate a long-term effect on teacher's IBL practice in class, because collaboration and reflection were mentioned as successful factors for long term effect of PD course (based on Capps et al., 2012). In addition, active learning, the content of PD courses is expected to have a long-term impact on professional development plans.

4. Method

A mixed-methods approach was used in this research. Semi-structured interviews and questionnaires were conducted for investigating the past and present thinking, teachers' teaching practice, and learning, IBL practice in a diversity of achievement. Semi-structured interviews (see: Appendix-Teacher interview) were performed with three Masdiv's case study teachers.

While conducting interviews, the case study teachers were asked to tell about their changed practice that included their experiences in implementing inquiry-based lessons in their classes and the constraints in the classroom that hinder the long-term practice of the PD course. Also, 26 teachers (participated in the previous Masdiv PD course) were required to complete

the questionnaire about their experiences that influenced their practice in inquiry-based teaching, the reason behind the hindrance in the long-term practice of the PD course, and suggestion for further improvement of the course.

This research was done to measure the long-term effects of Masdiv's professional development course on teachers' experience and practices related to IBL as an approach for achievement-related diversity and cultural diversity.

4.1. Participants

Two teachers from the Dutch-Masdiv and one teacher from Cyprus-Masdiv case studies participated in the interview. These Dutch case study teachers belong to U talent, an organization that is part of the Fredeunthal institute of Utrecht University (UU). Also, a questionnaire was shared with twenty-six other EU-Masdiv participant teachers by asking them to take part in the follow-up research. The questionnaire was shared as a link to google form. The questionnaire was also translated in Spanish for the language requirement of Spanish educators.

The first interview with teacher A was conducted at a high school in Oss. Before taking the PD course, she had no experience or training in IBL. The PD course was the first step (important) of her continuous professional development.

The second interview with teacher B was conducted at a vocational school in Zwijndrecht. She had followed the teacher training and has been teaching mathematics for nine years. Then she switched to teaching at the MBO (vocational education). The teacher had participated in several courses attended by the Freudenthal Institute.

The third interview was conducted with the teacher C from Cyprus. She works in a high school and 75% of students are of immigrant background.

4.2. Design of Instruments

4.2.1 Designing the instruments for interview Questions

Teacher's interview questions were designed for case study teachers who were willing to give interviews for the Masdiv-follow up research. Questions were related to IBL and experiences of teachers and diversity in class. The interview took about 45 minutes. The teacher interview questions consist of five sections (see: Appendix-teacher interview).

The first section of the interview gives the basic introduction of the research. It consists of an introduction to thank teachers for their willingness to participate in the interview, to introduce the aim of the interview, and to inform them about the audio recording and obtaining the signature of consent (Appendix-consent form). At the beginning of the interview, the teachers were presented with some inquiry-based teaching examples from previous Masdiv handouts.

The second section of question consists of two questions. One about teacher's personal experience in teaching and other question about their teaching subject. Questions about the personal background were inspired from previous Masdiv interview questions. The prompts

were used for further information to get insight into teachers' prior teaching experience. The codes for these questions are Pd-exp (experience in teaching practice) and Pd-sub (school subject teaching) (Appendix: interview coding) respectively.

The questions from third section of interview were selected based on the IBL in cultural contents (cultural diversity, diversity in intelligence) of all students in class. The questions are related to address diversity in achievement is adapted from Masdiv⁶ interview questions. In the interview, teachers were asked to discuss the influence of their belief in IBL practice in diversity. The prompts were used to get insight into teachers' beliefs about IBL and their prior experience in dealing with the diversity in class. The data collected from this section were analyzed to give answers to the first research question which was to know the factors influencing teacher's long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course. The codes used were IBL-Div-exp, IBL-Div-practise, IBL-Div-clg and IBL-Div-practice (Appendix: interview coding).

For the fourth section, the questions are related to management issues (i.e. lack of co-operation from school management) and pedagogical concerns(i.e. Is there a mismatch between acquired knowledge in personal development program and actual practice in class?) (based on Saberi & Amiri, 2016). The questions were used to understand the factors affecting the long-term effects of the PD program of teachers such as the school organizational conditions and activities, practicing and sharing expertise with colleagues who showed their interest in the program etc. The questions used codes (see: Appendix-interview coding), which gave the more insight into the factors affecting the long-term practice of PD course. The data collected from this section, were examined to give answers to the second research question.

Finally, the questions from fifth section gave answer to the third research question to get suggestions of teachers for the improvement of the long-term practice of personal development course (based on Gaikhorst et al., 2017). The study showed the support of school management and effective communication with colleague are key factors for the long practice of professional development course. The codes used to get more insight to the third research questions (Appendix: interview coding).

A pilot interview was carried out with two student-teachers. At the end of the interview, they provided valuable feedback to improve the questionnaire for the interview. There were some changes made to the questions related to diversity in the fourth part of the interview questions. According to the student-teachers, the term "diversity" should be made clear to the interviewee. As in Dutch culture, "diversity" usually misunderstood as race and sexuality, rather, the questions about diversity can be divided into two questions as follows, how would you describe the ethnic /cultural diversity in your class? And how would you describe the diversity in intelligence in your class? Also, another suggestion was to change the term "achievement-related diversity" to differences in performance in class as the Dutch teachers won't understand the term "achievement-related diversity" quite well.

4.2.2. Designing the instruments for questionnaire (Google-doc)

A questionnaire for teacher's was designed for all the participants of the Masdiv's professional development course (see: Appendix- Teacher questionnaire). The teachers were

⁶ Data collection instruments for case study Report/WP title: Data collection instruments for case study

required to complete the questionnaire to reflect their past and present thinking about the subject and their teaching practice while dealing with diversity.

The teachers' questionnaire consists of six sections.

The first section of the questionnaire gives the basic introduction of the research and reflects about the content of questionnaire. The second section of questionnaire consists of one open question about teacher's experience in teaching and one question about their teaching subject. In the third section, teachers were asked to choose an option to choose whether they are practicing PD course for a long time.

The fourth section of questionnaire consists of seven items. Five items based on the IBL in cultural contents for "all" students were selected from the Masdiv questionnaire. Here "all" refers to cultural diversity, diversity in intelligence of all students in class. The questions chosen from Masdiv questionnaire used a four-point Likert scale (Strongly agree, agree, disagree and strongly disagree). These items are part of the scale (Idb1, idb2, idb3, idb4, idb5). These scales gave the more insight into teacher's motivation for practicing IBL related diversity in class (see: Appendix-Teacher questionnaire: Item scale documentation)

The fifth section of questionnaire consists of six items. These items were selected based on analyzing the factors affecting the long-term effects of the PD course of teachers such as the school organizational conditions and activities, practicing and sharing expertise with colleagues who showed their interest in the PD course (based on Saberi & Amiri, 2016). The questions used a five-point Likert scale (Strongly agree, agree, neutral, disagree and strongly disagree). These items are part of the scale (Pd-management, Pd- pedagogical, PD-personal). These scales gave the more insight into the factors affecting the long-term practice of personal development course (Appendix-Teacher questionnaire: Item scale documentation).

The sixth section of questionnaire consists of six items. These questions used a three-point Likert scale (Yes, No, May be) and are part of the scale (PdI-collaboration, PdI-pedagogical, Pdi-management). These scales gave the more insight into the suggestions of teachers for the improvement of the long-term practice of personal development course (Gaikhorst et al., 2017; Monametsi, 2015) (Appendix-Teacher questionnaire: Item scale documentation).

4.2.3. Data Analysis

In order to analyze the data, both the response from the questionnaire and the semi-structured interviews were considered. These transcripts were analyzed using qualitative content analysis by Corbin & Strauss, (1990). Considering the findings from the interview, questionnaire, and comparing the items of IBL and diversity with previous Masdiv study, a coding scheme was developed considering the teachers' beliefs and attitudes about the implementation of IBL related to diversity.

The answer from open items from questionnaire were coded with a bottom-up approach. The grounded theory was followed by Corbin & Strauss, (1990). It was performed comparing answers, creating themes, sub codes) and reporting on most mentioned themes (with illustrative quotations) and 'remarkable' cases.

Table 1. with codes, sub codes and example quotes (questionnaire)

Topic	Sub code	Code-description	Quote
IBL & Diversity	IBL-Div-op	opportunity while practicing IBL in diversity	- Bi-lingual communication in class - create exercises using the diversity
	IBL-Div-clg	challenges while practicing IBL in diversity	- syllabus constraints - grouping students with different abilities
	IBL-Div-practice	Teaching practice in IBL and diversity	- Group work with mixed groups of students; presentations by students - Flipped classroom pedagogy
Hinderance of Pd	IBL-hind-Pd-tp	hinderance of practice due to lack of time	- Time can be an issue.
	IBL-hind-pd		- not intrinsically convinced

The interview data was coded with a bottom-up approach. The grounded theory was followed by Corbin & Strauss, (1990). First, the transcriptions were created. Then, the themes and their subthemes were identified in answers, and codes were generated for those subthemes.

This resulted in the following coding book/scheme:

Table 2. with codes and example quotes (interview)

Topic	Sub code	Code-description	Quote
IBL & Diversity	IBL-Div-exp	Experience in IBL and diversity	- experience with an exchange student during school cultural trips
	IBL-Div-practise	Teaching practice in IBL and diversity	- designing interactive game for students
	IBL-Div-clg	Challenges while practicing IBL and diversity	- no freedom to perform a new teaching practice in higher class
Hinderance of PD	IBL-hind-Pd-tp	Hinderance of professional development course due to time	- costs time
	IBL-hind-pd-scm	Improvement of professional development course due to school management	- School management is not supportive

	IBL-hind-pd-col	Improvement of professional development course due to colleagues	- it's more difficult to find others who wants to join and do a project together
Improvement of PD course	IBL-pdi-scm	Improvement of professional development course due to school management	- school management should organize a follow up PD course
	IBL-pdi-col	Improvement of professional development course due to colleagues	- formal meeting with small same subject teacher needed
	IBL-pdi-ol	Improvement of professional development course(online network)	- trying an interactive online community
	IBL-pdi-misc	Improvement of professional development course due to other things	- to do a new thing and implement it in a personal style

In the data analysis, the intercoder reliability of the interviews and results of the open questionnaire was tested by a second coder. In both cases the level of knowledge of the second coder proved adequate and the choice of the intercoder reliability check followed the research objectives. In the first coding, data were collected from interviews. In the second coding, the data was taken from the open questions of the questionnaire. To make the coding process transparent and reliable, for both cases a ‘coding and example document’ was developed in which the descriptions for coding were described. The second coder coded the interview and the open questions of the questionnaire aligned with the rules of the ‘coding and example document’.

We coded simultaneously one of the two interviews. At the beginning, there was a percentage match of 63%. Disagreements were mainly caused by difficulties in interpreting the teachers’ quotations (e.g., she coded “As a teacher, I am not in contact with the other cultural groups, but I would like to join if there is something happening” as IBL-hind-PD-grp, while it should be IBL-div-exp, because she got confused between the two codes). After a comparison of the coding and resolving these interpretation-issues we reached an 80.4% agreement which shows good inter-rater reliability.

Similarly, we coded the open questions in the questionnaire. At the beginning, there was a percentage match of 71.4%. Disagreements caused by differences in interpretations were resolved. During the discussion, it appeared that it is sometimes difficult to decide whether a quotation is about a practice or a challenge, e.g. “Sometimes when they are a top class (gifted/talented) they find it hard to go out in front of their classmates and speak”. We agreed that this quotation reflects a challenge, because it became difficult for groupwork and encouraging students to explain their methods and reasoning. After the discussion, we reached with an agreement of 85% which shows a good inter-rater reliability.

5.Results

The qualitative research was performed in six countries with three case teachers and twenty-six participant teachers to investigate the factors influencing teacher's long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course. To do so, we focused on three research questions: What are the factors that influence teacher's long-term IBL practices for addressing cultural diversity and achievement-related diversity acquired in the Masdiv PD course? What are the reasons behind the hinderance in long term practicing the IBL practices? How can be this PD course be improved to foster long term impact further in the future?

The key results for each question will be presented below to give the analysis of the questionnaires and interviews with teachers resulted in various issues related to long term implementation of IBL and addressing diversity in science classrooms. The results also indicate some suggestions for further improvement of the professional development course.

5.1. Topic: Inquiry based learning in diversity

Results from questionnaire:

The results of the questionnaire indicate that teachers are still practicing IBL in the classroom, with cultural diversity and achievement-related diversity (see: Figure-1). The responses demonstrated different methods, such as teamwork, and encouragement of students to explain their methods and reasoning. Teachers also used different methods like questioning techniques and show-me boards, real-life situations, group work, flipped classroom pedagogy, grouping students with different abilities, bilingual communication in class. Correspondingly, the teachers reported that they are implementing IBL with cultural diversity and achievement-related diversity in their lessons by respecting everyone's religion, by letting all adopting their own kind of recollection at the beginning of the lesson.

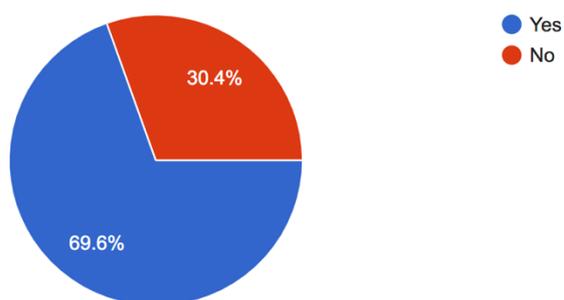


Figure 4. The responses of participating teachers (N = 26) show a high interest in practicing IBL with cultural diversity and intelligence diversity in class.

Comparison with the Masdiv questionnaire:

We compared five average scores between the items of IBL and diversity of Masdiv⁷ (N=376) and Masdiv follow up (N=26). The result (see: table-3) showed a positive increase in the teacher's self-efficacy in practicing IBL related to diversity. For instance, teachers felt more confident in designing learning activities in different cultural contexts, different cultural background and usage of inquiry-based activities in engaging all the students in the class.

Table 3. Showing comparison of average scores between scales of IBL and diversity in Masdiv and Masdiv-follow-up

Topic	Item	Average Masdiv follow up N=26	Item Masdiv N= 376	Average Masdiv
I can design learning activities situated in different cultural contexts.	Idb1	3.1	Se_cultural1	3.1
I can use inquiry-based activities to engage all of my students in learning.	Idb2	3.2	Se_ibl	3.2
I can plan practical/modeling activities that support all students in their learning.	Idb3	2.8	Se_ibl_hon	2.9
I can adapt my teaching to suit the student's different cultural backgrounds.	Idb4	3	Se_cultural2	3.05
I can build on a student's cultural backgrounds in my teaching.	Idb5	2.9	Se_cultural3	2.9

⁷ https://icse.eu/wp-content/uploads/2018/SonstigePDFs/WP3_Experimentation-protocol_D3.1_Pre-post-Questionnaire.pdf

Results from interview:

The interview with the teacher A showed about her willingness and positive attitude towards IBL. For instance, teachers felt more confident in designing activities (see: Appendix-teacher projects) by using elements from PD course.

One of the teachers stated as follows;

“ I tried to implement the elements of the PD course in a statistics project, which gave more freedom and also provided opportunities for students to develop their own data. Students can conduct an entire questionnaire survey on topics that interest them, and then perform their own statistical analysis on the data.” (Interview 28th Oct 2019)

Matching is an activity full of IBL-elements. The fact that the teacher A used it to let students discover part of the rules, without explaining them beforehand, makes it even more IBL-centered. She had prepared a matching activity to introduce the rules of exponentiation. In this activity, made sure that students of different achievement levels were all actively involved and able to keep up (see step by step approach: Appendix-teacher projects). During interview when asked about coping with the cultural diversity, the teacher A mentioned that she tries to be friendly with everybody. Even if there are some cultural differences, she doesn't know if she really put emphasis on it.

During the interview, teacher B mentioned that she had been able to make use of contexts when working on fractions (Interview 21st Nov 2019). Students had to organize a meal and calculate the needed amounts, the costs and planning. Afterwards students were motivated about the task and eager to actually learn about fraction. During one of her design tasks, she had designed a IBL-lesson using language map (see: Appendix-teacher projects). In this task, groups of students were given a mathematical concept and had to fill in a language map about the concept. The language map included the meaning of the concept, example sentences and a reverse concept. To do this task, the students had to investigate on the internet and discuss their answers.

As teacher C from Cyprus was working in a class with a high percentage of the migrant students, she had the experience to see how IBL enhances diversity. When playing games, some participants showed high performance, while some participants showed low performance. In order to implement the IBL activities, she formed groups with students of different abilities and worked together. She has implemented IBL in a “Jigsaw activity” to address achievement-related diversity for the group work (Interview 25th Feb 2020).

Comparison with the Masdiv interview:

Table 4. Table showing quotation of teachers about the successful implementation of Masdiv Professional development course in a multicultural classroom

Countries	Successful implementation of IBL by teachers in Masdiv follow-up (2019-2020)	Successful implementation of IBL by teachers in Masdiv (2018-2019)
-----------	--	--

Netherlands	- implemented in a statistical project - mathematical lessons practiced in class in the form of “cooking”.	-Prepared a lesson in which students would work in groups of four on an exam problem (focused on trigonometry)
Cyprus	- Designing a Jigsaw” activity for the group work with different ability students.	- A series of activities were designed for students in order to find out the fingerprints (using scientific procedures)

With respect to IBL the teachers indicated that this PD course has concrete materials, and it gave them ample ideas to implement IBL in their lessons. Table-4 shows successful implementation of IBL by teachers in Masdiv (2018-2019) and Masdiv follow-up research (2019-2020). For teachers, the PD course gave them insight into the use of contexts in their lessons. The teachers in the interview expressed the usefulness of new teaching practices in class and reported the improvement of student learning outcomes.

5.2. Topic: Reason behind the hindrance of implementation

Results from questionnaire:

The results from the questionnaire show that for most of the teachers, the “lack of time” factor is the main reason behind the hindrance of practicing IBL lessons in class. Other responses were, “time restrictions, time can be an issue, it needs time to prepare, planning time and implementation time.” Almost 85% of teachers believe that lack of time is the key factor in the hindrance of implementing IBL in the classroom (see: Figure-5). One of the experienced teachers (25 years) responded, “ these lessons/tasks require an amount of time in preparation and implementation; so sometimes it's easier to resort to the traditional method of teaching.”

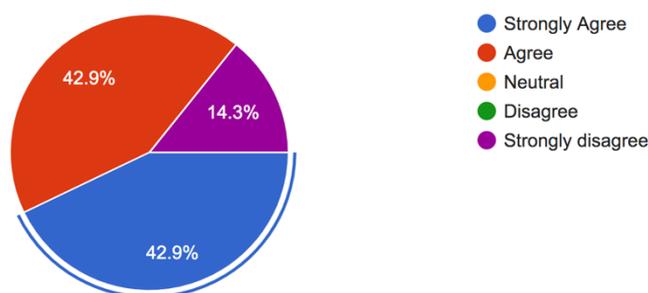


Figure 5. The questionnaire survey showed the answers to the main reasons behind the hindrance of IBL practice in the class for (N = 26) teachers

Results from interview:

In the interview, the teachers also mentioned that the biggest challenge is time management in the implementation of IBL elements in the classroom. In addition, there are other reasons, such as the lack of cooperation between school management. Teacher A mentioned that school management should spend some time in the course to implement the elements of the PD course (October 28, 2019, interview). Teacher C from Cyprus mentioned that the problem is to communicate in the Greek language in a multicultural class. Even though students could understand the essence of the subject, they couldn't express themselves (Interview 25th Feb 2020).

Comparison with the Masdiv interviews:

The interviews of previous Masdiv case studies showed similar concerns influencing the long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course.

The interview with teacher in Turkey showed that teachers faced some critical challenges in the classroom practices. They needed extra time, all of the students did not comprehend context when the contexts have a political dimension or value judgment, they cause troubles, and students' habits hinder to the quality of the classroom atmosphere. This problem comes from that students are not familiar with group working (interview, 16th May 2019, Masdiv Turkey).

The case studies of teachers identified the presence of large numbers of foreign students, behavioral problems and lack of motivation to learn as the key restrictions to addressing achievement-related diversity. Limited lesson time to do inquiry-based lessons appeared to be a problem for all teachers too (Interview Malta, Masdiv, 24/05/2018).

The interview with the teacher in Germany, described an uprising cultural diversity with immigrated students getting their vocational education at the school. This led to an increase of linguistic diversity, since many immigrant students are not fluent in German. (Interview Masdiv, 10th December, 2018).

Overall, after analyzing the questionnaire, interview and case studies of teachers of different countries used in previous Masdiv pd course, the following factors (see: Table-5) influencing the long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course have emerged.

Table 5. Factors influencing the long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course

Themes	Categories from Masdiv interview	Categories from Masdiv-follow-up interview
Management issue	<ul style="list-style-type: none">- Lack of time- Class room size- need opportunities to meet other teachers from different schools.	<ul style="list-style-type: none">- Lack of time- Lack of support from school management- Classroom size

Pedagogical concerns	<ul style="list-style-type: none"> - adapt the materials to the teaching practice in classes - presence of large numbers of foreign students - Students' habits - linguistic diversity - students' behavioral problems and lack of motivation to learn 	<ul style="list-style-type: none"> - Conflict between IBL and other teaching practices - Challenges concerning curriculum - Syllabus constraints
Personal concerns		<ul style="list-style-type: none"> - Not intrinsically motivated to change practice - Practicality

5.3. Topic: Recommendation for the further improvement

Results from questionnaire:

The responses from the questionnaire (see: Table-6) widely suggested by teachers were, “need for an online network with teachers to exchange ideas”, further coaching by school management “and “need for more course meeting” and “visit to other school who have participated in the course”. About 73.9 percentage of teachers suggested that there should be an online platform where you can find different lesson plans and ideas on how to implement new things (see: Figure-6). Also, the teachers showed their interest to learn more about the international aspects of the PD course and the other participating schools in different countries. Nearly 35 percentage of the teachers suggested that school management should organize a follow up PD course.

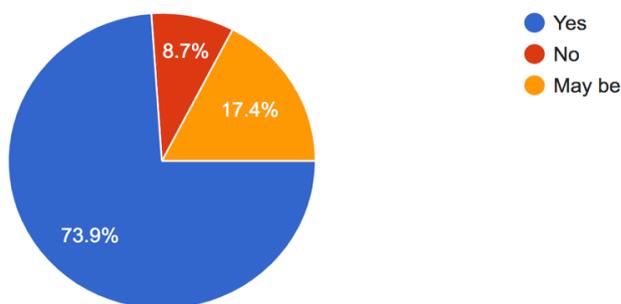


Figure 6. The responses of participating teachers (N = 26) show a high interest in sharing ideas in the online community network.

Table 6. showing the percentage of teachers' response from the questionnaire for further improvement of PD course.

Suggestions	Yes	No	May be
Need for an online network	73.9%	8.7%	17.4%
Further coaching by school management	21.7%	52.2%	26.1%
Visit to other school	50%	45.5%	4.5%
Guidance from other experience teacher	34.8%	26.1%	39.1%
Need for more course meeting	40.9%	18.2%	40.9%

Results from interview:

The results of the interview show suggestion for initiating discussion and interaction in smaller groups. Especially, the interaction between the same subject-teachers was of importance to these teachers as they can work, interact, cooperate, and exchange ideas together. Teacher A stated more specifically in an interview that it would be better if only PD sessions could be conducted with teachers from the same teaching background. Then it can be more beneficial for daily practice. While talking about the improvement of the PD course, she mentioned that a group would be better because it will be more personalized, comfortable, and effective. She believes that it is better to have the same group every time, then it is easier to improve this course (Interview 28th Oct 2019).

6. Discussion, Limitation and Recommendation

The aim of the research was to investigate the factors influencing teacher's long-term IBL practices for cultural diversity and achievement-related diversity in the Masdiv PD course.

In this study, we analyzed teachers' beliefs and attitudes about long term practice of inquiry-based activities in engaging all the students in the class. The Interviews with the teachers, response from the questionnaire, and comparison of the result with previous Masdiv case studies showed a positive implementation of IBL into the lesson and use this to work with the diversity in achievement in classes. As we can see from the results, after the PD course, teachers changed traditional practices and effectively implemented IBL (practices) in their classes.

As with any instructional strategy, the ability to handle IBL depends on the individual knowledge, skills, beliefs, attitudes, and experiences of the teachers (Guskey, 2002). The results of this study show that teacher A, who has no experience with IBL, successfully implemented the PD course content in her class. Lotter et al., (2016) research highlights the effect of the self-efficacy values of the teachers for IBL implementation. This is also expressed in the comments of teacher A and teacher B who both agreed that they were confident in circumstances where they successfully implemented the IBL projects in their class. The

teachers believed that IBL is an effective and but worthy instructive approach and said that they will continue to implement IBL in their classes. The questionnaire response and interviews revealed that participation in the PD course reduced the uncertainty of teachers regarding IBL 's implementation (capability and feasibility) as well as their concerns about its effectiveness. Experiencing ways to deal with their students' positive learning outcomes made the teachers talking positively about implementing IBL in their classes.

The teachers in the interview expressed the usefulness of new teaching practices in class and reported the improvement of students' learning outcomes. The evidence of improved student learning proved the change in a teacher's belief and attitude toward practicing the IBL in class. Also, in their lessons teachers allowed the students for a conversation with each other and let them work without intervening and provided groups with prompts when they got stuck. With this approach, the teachers made sure that students of different achievement levels could be actively involved with each other.

In addition to that the results from our research found out that materials and course content on IBL were highly sufficient and experienced as useful and interesting by the teachers. With respect to IBL they indicated that this PD course has concrete materials, and it gave them ample ideas to implement IBL in their lessons. For case study teachers (A, B and C), the course gave them insight into the use of contexts in their lessons. Hence, the conclusion drawn about the first research question that teacher's long-term implementation of IBL content in class satisfies several features of effective PD course such as teacher's knowledge of content, teacher's understanding of learner specific content, active learning (Capps et al., 2012).

Despite these positive developments, we identified some obstructive factors that the teachers are regularly limited by the school's curriculum and time-limit. What they liked most about the course is the 'content', which gave them many new ideas. But they indicated that more time could be devoted to the sharing of ideas among other teachers. The teachers were unable to implement innovative teaching approaches due to lack of time on task. As can be seen from the results, teachers suggested for more guidance and lack of support in the course of PD course, especially when planning IBL units for science subjects like mathematics and biology. This is possibly one of the main reasons why some of the teachers in this study could not change their practice fully. The interviews and responses from the questionnaire showed that the absence of support from school management and the lack of time was inconvenient for teachers, and it hindered their possibilities to implement IBL. They need to prepare for the existing curriculum and assessment. Hence, they have very little time to prepare for new teaching practices like IBL. These factors aligned with hindrance factors for the effectiveness of PD course (second research question) described by Saberi & Ameri (2016) which concerns the ineffectiveness of school management and teacher's dedicated time to PD.

The third research question was focused on the improvement of PD course in the future. During the interview, teachers mentioned that the course should be with a small group, and to make a group with the teachers from the same subject. As per teachers, this is good for personal progress so that when they feel more comfortable with the group, they can establish more personal connections with others. In addition to that, teachers suggested an online platform for networking to improve the course in the future. In the interview, the teachers also mentioned that the collaborative participation of colleagues may be another aspect of improving the PD course in the future.

The PD course in long term practice can be considered as effective because of the findings of this research. First of all, participating teachers can be considered highly dedicated and enthusiastic. From the results, it is obvious how much PD course affects teachers' daily practice, or how they tend to implement IBL in course units. Secondly, the lack of time and the support of school management, in particular, seem to have a great impact on classroom practice. Then, the recommendations for sharing, reviewing, and interacting with colleagues seem to be another major factor in the effectiveness of long-term practice of PD course (based on Capps et al., 2012). A regular and intensive collaboration can be established to improve the future of PD course, so as to plan and implement IBL units with teachers and reflect on their experience (Guskey, 2002). With extended support through an online network, teachers could be able to solve problems encountered when implementing IBL in the classroom.

Limitation & Recommendation

One of the limitations of this study is the limited sample size. Participation bias can have an impact, because only those teachers who are passionate about the Masdiv PD course have joined the study. Also, due to the difficulty in understanding in the English language used in interviews and questionnaires, it has not succeeded in satisfying fully the reliability of the research. Most of the teachers from the previous Masdiv project did not respond to the questionnaire due to the language barrier. The teachers were asking for the translation of some Dutch words during the interview. If the research still proves to be reliable in the future, these texts should be translated into Dutch. Only then can it reasonably be expected that participants will understand enough to fully answer the research questions.

In the current study, we investigated the long-term impact of Masdiv PD course on IBL practices on cultural diversity and achievement-related diversity. A recommendation for future research is to investigate whether the school management supports the teachers in implementing PD content after their participation in PD course. In addition, for future research, we recommend conducting this research with a larger sample size to better understand the long-term changes of teachers.

Implication

To sum up, teachers were satisfied with the Masdiv PD course. They showed a positive attitude toward adopting ideas and trying out more of the materials and ideas from the course. However, inquiry-based learning and solving diversity related to achievement were very time-consuming and difficult to implement correctly in the class. The main difficulty seems to be the time limit for teachers to prepare for inquiry-based learning tasks in the course. In addition, other elements, which were emphasized that the course should pay more attention to teachers' online network, collaboration, and interaction between colleagues and the network during PD meetings. These elements were considered by the teachers to be key components for the improvement of the Masdiv PD course.

“The opportunities are that the students won't be spoon-fed the information, but they are allowed to think and try to reason things out. By doing this, they will remember more and understand better.”

9. References

- Anderson, R. D. (2002). Reforming science teaching. What research says about inquiry. *Journal of Science Teacher Education*, 13(1), 1-12.
- Ballone, L. M., & Czerniak, C. M. (2001). Teachers' beliefs about accommodating students' learning styles in science classes. *Electronic Journal of Science Education*, 6(2), 4-29.
- Chapman, O., & Heater, B. (2010). Understanding change through a high school mathematics teacher's journey to inquiry-based teaching. *Journal of Mathematics Teacher Education*, 13(6), 445-458. doi:10.1007/s10857-010-9164-6
- Clarke, D. and Clarke, B. (2005). Effective Professional Development for Teachers of Mathematics: Key Principles from Research and a Program Embodying These Principles. 15th ICMI Study: *The Education and Professional Development of Teachers of Mathematics*. Águas de Lindóia, Brazil
- Crawford, B. (2000). Embracing the essence of inquiry: New roles for science teachers. *Journal of Science Teaching*, 37(9), 916-937.
- Capps, D.K., Crawford, B.A., & Constat, M.A. (2012): A Review of Empirical Literature on Inquiry Professional Development: Alignment with Best Practices and a Critique of the Findings. *The Association for Science Teacher Education*, USA 2012.
- Desimone, L. M. (2009). Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures. *Educational Researcher*, 38(3), 181-199. doi:10.3102/0013189x08331140
- Engeln, K., Euler, M., & Maass, K. (2013). Inquiry-based learning in mathematics and science: A comparative baseline study of teachers' beliefs and practices across 12 European countries. *Zdm*, 45(6), 823-836. doi:10.1007/s11858-013-0507-5
- European Commission. (2007). Key competences and basic skills. Retrieved from https://ec.europa.eu/education/policies/school/key-competences-and-basic-skills_en
- Eurydice. (2016). New Eurydice Report on Paris Declaration: developments in national education policies. Retrieved from <https://www.csee-etuice.org/en/news/archive/1421-new-eurydice-report-on-paris-declaration-developments-in-national-education-policies>
- Guajardo, J. (2011). Teacher Motivation: Theoretical Framework, Situation Analysis of Save the Children Country Offices, and Recommended Strategies. Retrieved from https://www.academia.edu/28952777/Teacher_Motivation_Theoretical_Framework_Situation_Analysis_of_Save_the_Children_Country_Offices_and_Recommended_Strategies
- Guskey, T. R. (2002). Professional Development and Teacher Change. *Teachers and Teaching*, 8(3), 381-391. doi:10.1080/135406002100000512
- Larina, G., & Markina, V. (2019). Hidden mechanisms of differentiation: Teachers' beliefs about student diversity. *Journal of Mathematics Teacher Education*. doi:10.1007/s10857-019-09436-1

Lotter, C. R., Thompson, S., Dickenson, T. S., Smiley, W. F., Blue, G., & Rea, M. (2018). The impact of a practice-teaching professional development model on teachers' inquiry instruction and inquiry efficacy beliefs. *International Journal of Science and Mathematics Education, 16*(2), 255–273.

MaSDiV – ICSE – International Centre for Stem Education. (2020, June 15). Retrieved from <https://icse.eu/international-projects/masdiv/>

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist, 55*(1), 68

Rogers, S. (2009). Rapid prototyping: A strategy to promote interest in STEM careers. *Paper Presented on US-Turkey Workshop on Rapid Technologies*. Retrieved from <http://iweb.tntech.edu/rrpl/rapidtech2009/rogers.pdf>

Vaughan, M. (2002). An Index for Inclusion. *European Journal of Special Needs Education, 17*(2), 197-201. doi:10.1080/0885625021013931

Appendix-1: Teacher interview

Part-A

Key questions

- 1) For how many years have you been a teacher?
- 2) How long have you been teaching at this school?
- 3) What courses have you taught?

Part-B (Teaching Practise)

Key questions:

- 1) How was the course relevant for your teaching practice (IBL)? Could you give an example?
- 2) What were the main challenges while practicing it (If any)? (Can you describe a key event?)

Extra questions:

- 3) Do you see any problems/difficulties? How often have you used inquiry-based learning in your teaching after taking Masdiv Pd course? Why?
- 4) What experiences, if any, have you had in using this new teaching practice with students? What went well and was difficult? Have you managed to overcome difficulties? How?

Part-C (Diversity)

Key questions:

- 1) How would you describe the ethnic /cultural diversity in your class?
- 2) How would you describe the diversity in intelligence/performance in your class?

Extra questions:

- 3) What activities/learning opportunities in Inquiry based learning lesson were particularly helpful to address diversity in intelligence/performance in your class?
- 4) Do you connect to the diverse community in school?

Part-D (Reason for hinderance of PD course)

Key questions:

Compared with their teaching before the professional development program, did it change after the program? Can you please describe the causes of the changes?

What is the reason behind it? (open questions)

If No: Have you tried it? Do you want to practice it?"

- Lack of time
- Conflict with the work schedule
- Is there a mismatch between acquired knowledge in personal development course and actual teaching practice in class?
- Is there a lack of co-operation from school management?
(Extra questions: - Did you get follow up support from school?
 - Lack of places/rooms in school?
 - Lack of support from colleagues?
- Lack of information in PD course
Extra questions:
 - Was the workshop effective?
 - Unfamiliarity with the teaching modules used?

Part-E (Suggestion for further Improvement of PD course)

- Do you see the opportunity for further support/improvement pd course? (starting open question)
- Would you satisfy with the number of meetings? (formal or informal)
- What do you think about a professional development network where you can share the knowledge about the course with other colleagues?

Appendix-2: Guideline for interview

The guidelines for semi structure interview (Appendix-interview guidelines) have been adapted from the previous Masdiv project interview guidelines. In qualitative research, the researcher is the primary instrument in the data generation (Paisley & Reeves, 2001) and interview questions are crucial aspects for collecting data while interviewing in-person. Furthermore, an in-person interview is broadly acknowledged as a suitable technique for qualitative inquiry to seek visions of interviewee (Collingridge & Gantt, 2008; Wimpenny & Gass, 2000). However, the introduction and the questionnaire for the interview has been changed as per the aim of the current research.

Guidelines for semi-structure interview

- Choose a place for the interview that's quiet and free from interruptions.
- Test the recording system.
- Record the interview. Transcript the interview afterwards. Merely taking notes will miss important information.
- Begin with an explanation of the purpose of the interview; intended uses of the information and assurance of confidentiality (see interview guideline). If appropriate, clarify that the interview has been approved by relevant officials.
- Ask only one question at once. Stay close to the wording you prepared in your interview guide.
- Enjoy the silence.
- Use probing techniques to get a deeper insight. (Would you give me an example? Can you elaborate on that idea? Would you explain that further? I 'm not sure I understand what you' re saying. , Is there anything else?)
- Maintain a neutral attitude. Interviewers should avoid giving the impression of having strong views on the subject under discussion.
- Do not put words into teachers' mouths. Let them say things in their own words.
- Provide feedback and reinforcement during the interview (Your comments on weakness are really helpful. We are about halfway through. You have been telling me really important things. How is it going for you?)
- Maintain control by knowing what you want to find out, by having prepared the interview guide and by listening attentively.

Appendix-3: Teacher Questionnaire

Questionnaire on inquiry-based learning and diversity

Dear teachers,

Thank you very much for agreeing to participate in my survey.

This questionnaire concerns your participation in a professional development course in 2018 or 2019 on inquiry-based learning and diversity. The questionnaire consists of 22 items and it will take 15 minutes at most to answer them. This course was developed under the umbrella of the Masdiv project which involved six European countries. The result will be used as a part of my educational research project at Utrecht University (UU), Netherlands. All responses will be confidential according to UU data management regulations.

Personal Data

By the end of this school year, how many years will you have been teaching altogether?

Please indicate the subject where you have implemented the personal development course?

1. Physics
2. Chemistry
3. Biology
4. <Integrated>science
5. None

Professional development course long term effect

Are you still practising strategies or using activities that were provided during the course?

1. Yes
2. No

Inquiry Based Learning and Diversity

I can design learning activities situated in different cultural contexts.

1. Strongly agree
2. Agree
3. Disagree
4. Strongly disagree

I can use inquiry-based activities to engage all of my students in learning.

1. Strongly agree
2. Agree
3. Disagree
4. Strongly disagree

I can plan practical/modeling activities that support all students in their learning.

1. Strongly agree

2. Agree
3. Disagree
4. Strongly disagree

I can adapt my teaching to suit the student's different cultural backgrounds.

1. Strongly agree
2. Agree
3. Disagree
4. Strongly disagree

I can build on a student's cultural backgrounds in my teaching.

1. Strongly agree
2. Agree
3. Disagree
4. Strongly disagree

What do you see as opportunities and/or difficulties of Inquiry-based learning to day to day teaching?

What strategies do you use regarding diversity in your class?

What hinders the implementation of the course in your class?

Conflict with work schedule?

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Lack of time?

5. Strongly agree
6. Agree
7. Neutral
8. Disagree
9. Strongly disagree

Not suitable for my teaching practice?

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Lack of support from school?

1. Strongly agree
2. Agree
3. Neutral
4. Disagree

5. Strongly disagree

Lack of support from colleagues?

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Lack of information in professional development course?

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Recommendation for further improvement for the professional development course

Do you need more course meeting?

1. Yes
2. No
3. May be

Is there a need for a network(online) with teachers to exchange ideas?

1. Yes
2. No
3. May be

Do you need a further coaching by school management?

1. Yes
2. No
3. May be

Do you need an observation visit to other schools who have participated in the course?

1. Yes
2. No
3. May be

Do you need guidance from other experienced teachers who have participated in the course?

1. Yes
2. No
3. May be

Other reason:

Appendix-4: Teacher questionnaire - Item scale documentation

Personal data

code	Item
Exp	By the end of this school year, how many years will you have been teaching altogether?
Sub	Please indicate the subject where you have implemented the personal development course?

Inquiry based learning and diversity

code	Item
ibd1	I can design learning activities situated in different cultural contexts.
ibd2	I can use inquiry-based activities to engage all of my students in learning.
ibd3	I can plan practical/modelling activities that support all students in their learning.
ibd4	I can adapt my teaching to suit the student's different cultural backgrounds.
ibd5	I can build on a student's cultural backgrounds in my teaching.
ibd6	What do you see as opportunities and/or difficulties of Inquiry-based learning to day to day teaching?
IBL-Div-op	
IBL-Div-clg	
IBL-practise	
ibd7	What strategies do you use regarding diversity in your class?
IBL-hind-pd-cla	

What hinders the implementation of course in your class?

code	Item
Pdh1	Conflict with work schedule
Pdh2	Lack of time
Pdh3	Not suitable for my teaching practise
Pdh4	Lack of support from school
Pdh5	Lack of support from colleague
Pdh6	Lack of information in professional development course
Pdh7	IBL-hind-Pd-tp Other Reason

	IBL-hind-Pd	
--	-------------	--

Recommendation for the further improvement of the professional development course

Code	Item
Pdi1	Do you need more course meeting?
Pdi2	Is there a need for a network(online) with teachers to exchange ideas?
Pdi3	Do you need a further coaching by school management?
Pdi4	Do you need an observation visit to other schools who have participated in this course?
Pdi5	Do you need guidance from other experienced teachers who have participated in this course?
Pdi6	Other Reason

Appendix-5: Interview coding

	Code description	Sub code	Code description	QUOTES
PB	Personal Background	PB: exp	PB: years experienced	17 years (Loes) 10 years (Randy)
		PB: sub	PB: subject	Mathematics (Loes) Finance/economics (Randy)
		PB: Practice	PB: teaching practice	<ul style="list-style-type: none"> - Loes struggled to analyze large databases (prior experience). She implemented it in a project and it gave more freedom to children as it gave opportunity for the students to develop their own data. - Randy is still experimenting with all the things she learned during pd course and implementing it in the form of games.
IBL-Div	IBL and diversity	IBL-Div- Exp	Experience while teaching IBL & diversity	<ul style="list-style-type: none"> - Loes had no experience on cultural diversity in class. But she had experience with an exchange student during school cultural trips - Randy has experience in cultural diversity in class. She practice it in class in the form of "cooking".(from different culture). -
		IBL-Div-clg	Challenge while practicing IBL & diversity	<ul style="list-style-type: none"> - one of the challenge is to convince students to follow IBL. Because there are other ways of learning mathematics and students will get the same result at the end.(Loes)
		IBL-DIV-practice		

				<ul style="list-style-type: none"> - There is no freedom to perform a new teaching practice in higher class such as VWO-5.(Loes) - It is difficult to implement in MBO. It is easier to implement in Havo/VWO.(Randy)
IBL hind-PD	Reason of hinderance in IBL teaching practice	IBL-hind-PD-tp		<ul style="list-style-type: none"> - It costs time to develop and to adapt things that you learn to your daily practice. (Loes) - There is language barrier in a multicultural class. (Randy)
		IBL-hind-PD-scm	hinderance due to School management	<ul style="list-style-type: none"> - No follow up from the course (Randy) - school don't know what we are doing (Randy) - School management gives us some hours to develop things, but it's all what they think should be changed in school, but not what teachers wants to change. (Loes)
		IBL-hind-PD-col	hinderance due to absence of colleague support	<ul style="list-style-type: none"> - You cannot support a project with two persons. (Randy) - if you want to change it as one person, then it's more difficult to find others who wants to join and do it.(Loes)
IBL PD	Suggestion for further improvement	IBL-pdi-scm	support from school management	<ul style="list-style-type: none"> - school management should organize a follow up PD course (Randy) - If the school management would give you some hours to develop things, it will be great. (Loes)

		IBL-pdi- col	Support from colleagues	<ul style="list-style-type: none"> - There should be a small formal group. (Loes) - I think it is more effective if you have only with mathematical teachers. (Loes) -
		IBL-pdi- ol	Online community	<ul style="list-style-type: none"> - I only know how to use google. (Loes) - I don't know if an interactive Community will help, but we can try. (Randy)
		IBL-pdi-misc	Other comments	<ul style="list-style-type: none"> - I think that there must be more exercises (Loes) - I like to do a new thing and implement it in my style. It would be better if somebody from team will help with the project. (Randy)

Appendix-6: Teacher consent form

I want to thank you for allowing me to observe your lesson and for taking time to meet with me today.

My name is _____. I am _____ *<if appropriate, short introduction of the interviewer, position in the project>*.

I would like to talk to you about the Masdiv PD course about inquiry-based learning and diversity.

The interview is part of the evaluation of the Masdiv follow up project which involves 6 European countries.

The aim of this interview is to obtain insight into how teacher perceived the Masdiv PD course and how to improve the PD course. Furthermore, we want to find out how teachers deal with diversity in their classrooms. The interview will take about 45 min. I will be recording the session because I don't want to miss any of your comments.

All responses will be kept confidential. We ensure that any information we include in our report does not identify you as the respondent.

Remember, you don't have to talk about anything you don't want. You may end the interview at any time.

Are you willing to participate in this interview?

I am willing to participate in the interview

Name

Signature

Date

Appendix-7: Teacher-Projects

Matching Activity:

243	6561	216	1	$\frac{1}{81}$	738	81
X^5	X^8	$x^3 \cdot y^3$	X^0	X^{-4}	$\neq X^8$	X^4
3^5	3^8	$2^3 \cdot 3^3$	3^0	3^{-4}	$3^6 + 3^2$	3^4
3.3.3.3.3	$\frac{(3.3)(3.3)}{(3.3)(3.3)}$	$\frac{(2.3)(2.3) \cdot (2.3)}{2.3}$	$\frac{3.3.3.3 \cdot 1}{3.3.3.3 \cdot 1}$	$\frac{1}{3.3.3.3} = \frac{1}{3^4}$	$\frac{3.3.3.3.3.3}{+3.3}$	$\frac{3.3.3.3.3.3 \cdot 3^4}{3.3 \cdot 1}$
X^{2+3}	$X^{2 \cdot 4}$	$xy \cdot xy \cdot xy$	X^{4-4}	X^{0-4}	Kan niet korter	X^{6-2}
$X^2 \cdot X^3$	$(X^2)^4$	$(xy)^3$	$X^4 : X^4$	$X^0 : X^4$	$X^6 + X^2$	$X^6 : X^2$

Statistical project:

Excel project 5wvo_Omgaan met grote data bestanden

- Maak groepjes van maximaal 3 personen.
- Maak zelf een enquête en houd rekening met de gestelde voorwaarden bij de presentatie.
- Neem de enquête zelf af en verwerk alle data in een Excel sheet.
- Zorg voor 50 respondenten en 8 vragen.
- Presenteer je onderzoekje in een PowerPoint presentatie van maximaal 5 minuten.

De enquête moet voldoen aan de volgende voorwaarden:

1. nominale variabele
2. boxplot
3. gemiddelde en standaard afwijking
4. draaitabel met conclusie
5. Pie diagram = cirkel diagram
6. frequentiepolygoon
7. beantwoord door slim gebruik te maken van filters zelf gestelde vragen of verbanden. bv de mensen die groen als lievelingskleur hebben, zijn het vaakst op zondag geboren. Minimaal 5 vragen/ verbanden aangeven.

De enquête mag overal over gaan. Leef je uit! Voorbeelden.

- Vaas met knikkers hoe lang duurt het in seconden voordat iemand een rode knikker pakt.
- Laat iemand een stukje tekst voorlezen en neem de tijd op totdat diegene gaat lachen,
- hoen experiment met mini marsjes snickers bounty's etc. Welke wordt gekozen?
- Hoe vaak en hoelang en waarnaar kijkt men Netflix
- wie heeft er een 7 in zijn telefoonnummer zitten
- etc.

Het punt wordt bepaald door:

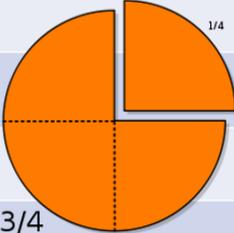
1. PowerPoint presentatie
2. PowerPoint presentatie max 5 minuten
3. Excelsheet inleveren
4. 1 leeg enquête formulier

Activity	Performed by
Students receive their assignments and are told to Build an opinion of themselves	Teacher
Students set up research.	Student groups
Group discussion with other groups; is the set-up ideal and does each group know how to proceed?	Whole group <input type="checkbox"/>
Students process all data in an Excel sheet	Student groups
Presenting the process and the findings	Whole group
Students discuss and evaluate their process	Student groups
Evaluation of the processes What else can be done?	Whole group

With the above-mentioned approach Teacher, A made sure that students of different achievement levels are all actively involved in the task.

Language map

Word	Graph	Image
Is <u>used in</u> :	<u>Mathematics</u>	
<u>Meaning or translation</u>	A <u>visual 2D representation of a function</u>	
<u>Example sentence</u>	Make a <u>graph according to this table</u>	
= <u>the same</u>	A <u>visual 2D representation of a function</u>	
≠ reverse concept	<u>Table</u>	
<u>Related words</u>	2D, function	

Word	Quarter	Image
Is used in:	<u>Calculation and pie diagrams</u>	
<u>Meaning or translation</u>	Half of a half	 <p>3/4</p> <p><small>Deze foto van Onbekende auteur is gelicentieerd onder CC BY-SA</small></p>
<u>Example sentence</u>	Jorren ate <u>three quarters of the cake</u>	
= <u>the same</u>	Jorren is full	
≠reverse concept	It is <u>not</u> a half	
<u>Related words</u>	<u>Whole, half, three quarters</u>	