

## MASTER

### Formative assessment during student projects

How can formative assessment be applied to long-term projects in secondary school education to contribute to the process of deep learning among students?

Dieker, T.S.T.; Huige, C.J.M. (Kees)

*Award date:*  
2022

[Link to publication](#)

#### **Disclaimer**

This document contains a student thesis (bachelor's or master's), as authored by a student at Eindhoven University of Technology. Student theses are made available in the TU/e repository upon obtaining the required degree. The grade received is not published on the document as presented in the repository. The required complexity or quality of research of student theses may vary by program, and the required minimum study period may vary in duration.

#### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain

## Research

# Formative assessment during student projects

How can formative assessment be applied to long-term projects in secondary school education to contribute to the process of deep learning among students?

Research performed by:

T.S.T (Tijn) Dieker BSc  
1004748  
Onderzoeken & Ontwerpen  
Physics

Ir. C.J.M. (Kees) Huige  
0328299  
Computer Science

Supervisors:  
Prof. Dr. J. Vermunt, Ir. E. Quant

Research performed during the course: "Practical educational research"  
(EME40 + EME41 10EC-variant)

## Verklaring inzake TU/e Gedragscode Wetenschapsbeoefening in het kader van de Masterscriptie

Ik heb kennis genomen van de TU/e Gedragscode Wetenschapsbeoefening<sup>1</sup>.

Hierbij verklaar ik dat mijn Masterscriptie conform de regels van de TU/e Gedragscode Wetenschapsbeoefening tot stand is gekomen.

Datum

20-1-2022

Roepnaam Achternaam (student 1)

Roepnaam Achternaam (student 2)

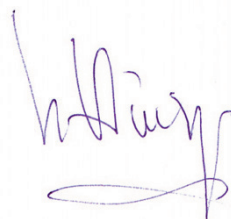
Tijn Dieker

Kees Huige

Handtekening (student 1).



Handtekening (student 2).



*Lever de ondertekende verklaring in bij de coördinator van Onderzoek van Onderwijs*

---

<sup>1</sup> Zie: <http://www.tue.nl/universiteit/over-de-universiteit/integriteit/wetenschappelijke-integriteit/>

Hier is ook de Nederlandse Gedragscode Wetenschapsbeoefening van de VSNU te vinden. Meer informatie over wetenschappelijke integriteit is te vinden op de websites van de TU/e en de VSNU.

# Index

<b>VERKLARING INZAKE TU/E GEDRAGSCODE .....</b>	<b>2</b>
<b>INDEX .....</b>	<b>3</b>
<b>SAMENVATTING .....</b>	<b>5</b>
<b>SUMMARY .....</b>	<b>7</b>
<b>1 INTRODUCTION .....</b>	<b>8</b>
1.1 THE SUBJECT OF THE STUDY .....	8
1.2 THE REASON FOR THE PROPOSED RESEARCH .....	8
1.3 THE IMPORTANCE OF THIS RESEARCH .....	9
<b>2 THEORETICAL EMBEDDING .....</b>	<b>9</b>
2.1 FORMATIVE ASSESSMENT .....	9
2.2 PROJECT MANAGEMENT .....	12
<b>3 THE ELABORATION OF THE RESEARCH QUESTIONS .....</b>	<b>12</b>
<b>4 THE METHOD OF THE RESEARCH .....</b>	<b>13</b>
4.1 PHASE 1: NEEDS & CONTEXT ANALYSIS .....	13
4.1.1 <i>Target group</i> .....	13
4.1.2 <i>Materials</i> .....	14
4.1.3 <i>Procedure</i> .....	14
4.1.4 <i>Analysis</i> .....	14
4.2 PHASE 2: LITERATURE RESEARCH .....	14
4.2.1 <i>Materials</i> .....	15
4.2.2 <i>Procedure</i> .....	15
4.2.3 <i>Analysis</i> .....	15
4.3 PHASE 3: PROVIDE GUIDELINES HOW FORMATIVE ASSESSMENT CAN BE IMPLEMENTED .....	15
4.3.1 <i>Target group</i> .....	15
4.3.2 <i>Materials</i> .....	15
4.3.3 <i>Procedure</i> .....	15
4.3.4 <i>Analysis</i> .....	16
<b>5 RESULTS .....</b>	<b>16</b>
5.1 PHASE 1: NEEDS & CONTEXT ANALYSIS .....	16
5.1.1 <i>How are formative assessments currently done in schools?</i> .....	16
5.1.2 <i>What kind of project management methodologies are currently used?</i> .....	18
5.2 PHASE 2: LITERATURE RESEARCH .....	20
5.2.1 <i>Which elements found in the analysis can be ensured by formative assessment?</i> .....	20
5.2.2 <i>Which instruments in the project management methodology can contribute to improving formative assessment during student projects?</i> .....	21
5.2.3 <i>Selecting the best method</i> .....	24
5.2.4 <i>Focus on product and learning goal</i> .....	25
5.2.5 <i>Reflection</i> .....	26
5.2.6 <i>Feedback</i> .....	27
5.2.7 <i>Planning work</i> .....	28
5.3 PHASE 3: GUIDELINES FOR PROJECTS WITH FORMATIVE ASSESSMENTS .....	29
5.3.1 <i>Step 1 Selecting proper approach</i> .....	29
5.3.2 <i>Step 2 Execution with formative assessments</i> .....	30
5.3.3 <i>Formative assessment during a Waterfall project</i> .....	30
5.3.4 <i>Formative assessment during a Lean-Kanban project</i> .....	33
5.3.5 <i>Formative assessment during an Agile-Scrum</i> .....	36
5.3.6 <i>Feedback on research results</i> .....	39
<b>6 CONCLUSION AND DISCUSSION .....</b>	<b>39</b>

6.1	FINDINGS.....	40
6.2	CONTRIBUTIONS OF THE STUDY .....	41
6.3	LIMITATION OF THE STUDY .....	42
6.4	FUTURE RESEARCH.....	42
<b>BIBLIOGRAPHY.....</b>		<b>43</b>
<b>APPENDIX 1: QUESTIONNAIRE STORYBOOK USED DURING THE INTERVIEWS.....</b>		<b>46</b>
<b>APPENDIX 2: QUALITATIVE DATA OBTAINED FROM THE INTERVIEWS (SELECTION).....</b>		<b>50</b>
<b>APPENDIX 3: INFOGRAPHIC GUIDELINES.....</b>		<b>51</b>
<b>APPENDIX 4: EVALUATION FORM .....</b>		<b>54</b>

## Samenvatting

(Dutch summary)

Het onderzoek dat in dit verslag wordt beschreven gaat over formatief beoordelen tijdens langlopende projecten voor de schoolvakken Informatica en O&O (O&O staat voor "Onderzoeken en Ontwerpen"). De bijdrage van formatieve toetsing binnen leerprocessen van leerlingen in het voortgezet onderwijs, is een onderwerp dat al veelvuldig is onderzocht. Echter, onderzoek naar de effecten van formatieve evaluatie specifiek tijdens langlopende projecten is beperkt. Tijdens de initiatie van dit onderzoek werden overeenkomsten geconstateerd tussen projectmanagementmethoden in het bedrijfsleven en formatieve beoordeling in de klas tijdens projecten. Dit gegeven, vormde de start van dit onderzoek met als doel om een antwoord te vinden op de volgende onderzoeksvraag:

*"Hoe kan formatieve assessment worden toegepast bij langlopende projecten in het voortgezet onderwijs om bij te dragen aan het proces van diep leren bij leerlingen?"*

Om tot een antwoord te komen op deze vraag waren de volgende deelvragen geformuleerd:

1. Hoe worden formatieve assessments momenteel uitgevoerd op scholen?
2. Wat voor soort projectmanagementmethodologieën worden momenteel gebruikt?
3. Voor welk deel van de bevindingen gevonden in onderzoeksvraag één en twee kan formatieve evaluatie gunstig zijn?
4. Welke instrumenten in de projectmanagementmethodologie kunnen bijdragen aan het verbeteren van formatieve beoordeling tijdens studentenprojecten?
5. Welke richtlijnen zouden docenten die lesgeven in langlopende projecten kunnen hanteren om formatieve beoordeling te verbeteren en zo bij te dragen aan het leerproces bij leerlingen?

Deze deelvragen zijn tijdens het onderzoek in drie verschillende fasen onderzocht en beantwoord. Deze fasen binnen het onderzoek waren een veldonderzoek, een literatuurstudie en een ontwerpfase met terugkoppeling.

### Veldonderzoek

In de eerste fase werden docenten geïnterviewd om de behoeften aan formatieve evaluatie vast te stellen en om te achterhalen welke methoden al werden gebruikt voor het managen van projecten. Hiermee werden de eerste twee deelvragen beantwoord.

Docenten deden op verschillende manieren aan formatieve evaluatie, maar niet altijd op een structurele manier. Hun aanpak was niet van tevoren uitgedacht, maar werd beschouwd als een algemene manier van werken. Voor het managen van de projecten werden elementen uit de Agile-methode en de Watervalmethode deels gebruikt tijdens de lessen. Echter bijna geen van de docenten gebruikte deze methode als onderdeel van het formatieve beoordelingsproces.

### Literatuurstudie

Tijdens de tweede fase werden de resultaten van de eerste fase gebruikt als invoer voor een literatuuronderzoek over formatieve evaluatie en projectmanagement. Dit verschaftte inzicht in de aandachtspunten die formatief ondersteund dienden te worden door een projectmanagementmethode tijdens een leerlingenproject en gaf antwoord op de derde en vierde deelvraag.

Uit onderzoek in de wetenschappelijke literatuur bleek dat formatief toetsen geschikt was om te gebruiken tijdens de uitvoering van projecten. Het biedt ondersteuning op vier aandachtspunten die een belangrijke rol spelen bij de uitvoering van langlopende projecten en de kans op het succesvol behalen van de leerdoelen. De vier aandachtspunten voor leerlingen zijn:

- Houd focus op projectdoelen en leerdoelen.
- Voer reflectie uit op de weg die is afgelegd om de leerdoelen te bereiken.
- Verkrijg feedback op de uitgevoerde activiteiten tijdens het project.
- Zorg voor planningswerk tijdens de uitvoering van het project.

Uit literatuuronderzoek bleek verder dat er drie hoofdgroepen van projectmanagementmethoden zijn, te weten: Waterval, Lean-Kanban en Agile Scrum. De laatste twee methoden hebben een iteratieve werkwijze waarbij de volgorde van het uitvoeren van de activiteiten minder belangrijk is dan bij de Watervalmethode. Bij de Watervalmethode is de output van de vorige fase input voor de volgende fase en kan daarom niet iteratief worden genoemd. De analyse gaf ook inzicht over welke methode in welke situatie het beste kan worden toegepast. Alle drie de methoden hebben voor- en nadelen en zijn elk geschikt voor een specifieke situatie. Watervalmethoden zijn de beste keuze wanneer de weg naar het bereiken van de projectdoelen en leerdoelen van tevoren duidelijk is uitgestippeld. Agile-Scrum methode heeft de voorkeur wanneer de weg naar het bereiken van de projectdoelen en leerdoelen in het begin en tijdens de uitvoering onduidelijk is.

Verdere analyse van de onderzoeksgegevens heeft ook aangetoond dat alle drie methoden in een klassikale omgeving kunnen worden toegepast. Hoewel elke projectmanagementmethode anders omgaat met de vier hierboven beschreven aandachtspunten, worden de aandachtspunten door alle drie de methoden ondersteund. De uiteindelijke uitkomst van deze fase gaf een vertaling van elke methode naar een klassikale omgeving die als input diende voor het beantwoorden van de laatste deelvraag en de hoofdvraag.

### Ontwerpfase

In de derde en laatste fase werden de bevindingen van de tweede fase vertaald in aanbevolen richtlijnen voor formatieve evaluatie tijdens projecten. Voor elke projectmanagementmethode zijn deze richtlijnen uitgewerkt en bieden ze een hulpmiddel voor de docent. De docent kan deze richtlijnen implementeren in een studentenproject. De richtlijnen geven ook advies over welke projectmanagementmethode het beste gebruikt kan worden in een specifieke situatie. Elke projectmanagementmethode heeft zijn eigen sterke en zwakke punten, en het is belangrijk om de juiste methode te gebruiken voor een specifiek studentenproject. Deze richtlijnen werden geëvalueerd door docenten en ook deze bevindingen worden gerapporteerd in dit verslag.

Door het toepassen van de juiste richtlijnen bij de juiste projectmethoden met de beschreven formatieve toetsing bij langdurige projecten is het de verwachting dat dit een positieve bijdrage zal geven aan het leerproces bij de leerlingen tijdens het uitvoeren van langdurige projecten.

De uitkomsten van dit onderzoek geeft ook mogelijkheden voor een vervolgonderzoek waarbij een meer praktische uitwerking van de richtlijnen getoetst kunnen worden in de praktijk.

**Trefwoorden:** Formatieve beoordeling, formatieve evaluatie, leerlingenprojecten, projectmanagement, waterval, agile, middelbare school, informatica, O&O (Onderzoek en Ontwerp).

## Summary

This study is about formative assessment during long-term projects in the school subjects Computer Science and O&O (O&O stands for “Onderzoeken en Ontwerpen” which translates into “Research & Design”). The contribution of formative assessments within learning processes by secondary school students, is a topic that has been investigated many times. However, research on the effects of formative assessment specifically during long-term projects is limited. During the initiation of this research, similarities were noted between project management methods in business and formative assessment in the classroom during projects. This fact parked the start of this research.

The study consisted of three different phases: field research, a literature review followed by a design phase.

In the first phase, teachers were interviewed to determine the needs for formative evaluation and to find out what methods were already in use for managing projects. Teachers were doing formative evaluation in different ways however not always in a structural way. Their approach was not thought out in advance but was considered a general way of working. To manage the projects, elements from the Agile method and waterfall methods were used partly intentionally. Nearly none of the teachers used this method as part of the formative assessment process.

During the second phase, the results of the first phase were used in combination with literature research on formative evaluation and project management. This provided insight into the focus areas that needed to be formatively supported during a student project by a project management tool. The four focal points were: 'focus on product and learning goal', 'planning the work', 'giving feedback' and 'reflecting on execution'. The three groups of project management tools that could support these aspects were 'Waterfall', the combination of Lean with Kanban and Agile combined with Scrum. The study also explained how each group of methods could support formative assessment during the learning process.

During the third and the final phase, the findings of the second phase were translated into recommended guidelines for formative evaluation in projects. For each project management method, these guidelines are elaborated and provide a tool for the teacher. The teacher can implement these guidelines in a student project. The guidelines also provide advice on which project management method is best to use in a specific situation. Each project management method has its own strengths and weaknesses, and it is important to use the right method for a specific student project. These guidelines were evaluated by teachers and the findings were reported in the study.

**Key words:** formative assessment, formative evaluation, student projects, project management, waterfall, agile, high school, computer science, O&O (Research and Design).



# 1 Introduction

## 1.1 The subject of the study.

This study aims to define a set of proposals to improve the way formative assessment is done in long term class projects at secondary education schools. In this study we define formative assessment as using learning outcomes to improve the learning process (Black & Wiliam, 1998).

Examples of long-term projects are the profiling exercises as well as projects carried out during computer science and O&O (Onderzoeken & Ontwerpen translated as Research & Design) lessons. We focus on projects with a turnaround time of about eight weeks.

## 1.2 The reason for the proposed research

In recent decades, the economy has changed from a manufacturing economy to a knowledge economy (Stewart, 2010). As a result of this knowledge industry, its competitions such as collaborating and working with multidisciplinary projects have become much more important (Trilling, & Fadel, 2009). Because of this change in our society, it is also essential that secondary education responds to this change, and with the introduction of 21st-century skills within education, the gap between what students can do and what the business community demands must be reduced (Trilling & Fadel, 2009). Nowadays, graduates are often not ready for the work they will be doing (Casner-Lotto & Barrington, 2006).

Deep learning is essential in order to master both knowledge and skills which are needed in the 21st century. Besides, the application of 21st competences support deep learning among students (Pellegrino & Hilton, 2013). An excellent way to fit this into the lessons is to have the students carrying out projects. Students are usually set to work independently while carrying out the analysis and research, which strongly promotes deep learning in the subject (Trilling, & Fadel, 2009; Parker, 2018). This means project learning can be a valuable part of today's education.

Formative assessment and feedback do overlap (Black & Wiliam, 1998). A part of the formative assessment is the teacher's feedback to help the learners proceed forward. During the realisation of the projects, the teacher can use these feedback moments to stimulate deep learning (Czerkawski, 2014). Although, it is quite complex to measure the progress of the individual students during implementation (Thomas & Busby, 2003).

In a meta-analysis Black and Wiliam (1998) found that formative assessment improves learning outcomes. Especially conversations in which the students assess their own work while the teacher and students compare their work to the evaluation criteria. Feedback as part of formative assessment helps students to connect their current activities to reach the desired learning goal (Ramaprasad, 1983). This is also desired in learning in bigger projects.

Projects at secondary schools are usually carried out to meet students learning goals, and formative assessments are used to provide some structure in reaching these goals. Likewise, In the last 50 years the business world has developed project management methods to help business teams to reach business goals in a structured way.

However, reaching learning goals in the classroom differs from reaching business goals on the business floor. The goals are most of the time different, in classroom the learning goal is an individual goal of the student, while at the working floor it will be more likely a team goal. In the working scenario success factors are mostly based on used resources and profitability, while in the classroom the project deliverables are less important than reaching the learning goal.

As both school and business projects scenarios present similarities, we want to investigate whether certain elements project management theory can improve the assessments in student projects. Also, we want to investigate if certain tools can be integrated in formative assessment activities.

In order to improve the quality of project education in secondary education, first we want to identify the problems teachers have with formative assessment or find reasons why they do not implement it. Following, the design phase in which project management literature is used to improve formative assessment in school. Lastly, the designed guideline will be setup as basis for a pilot with students.

### 1.3 The importance of this research.

According to our observations, it is not so easy to integrate projects into education. Educational methods are often not geared to this, and therefore teachers have little experience and knowledge in project learning, or students are very much at liberty during implementation, and a robust assessment only takes place at the end. This will be validated in the first part of the research. Formative assessment during the execution of the project could improve learning in these projects. Formative assessment needs several 'moments of contingency' to be effective. Teacher's next steps are usually not planned beforehand because the path to reach the learning goal is not yet clear at beginning of the project. (Leahy, Lyon, Thompson & Wiliam, 2005; Black & Wiliam, 2009). For example, more instruction on a particular theory needed as part of the project or feedback to help learners move from a dead end to the execution. During the execution of a project, learning is important for teachers to help students define the next steps, and feedback on the quality of their work is important (Mergendoller, Markham, Ravitz & Larmer, 2006).

Several parts of effective project management are similar to effective formative assessment. Having clear goals/objectives is listed as most important factor of success in project outcome (White & Fortune, 2002), which is similar to clarifying learning goals in the school setting (Black & William, 2008). Similarly, effective monitoring and feedback are closely related to teacher's monitoring learning goals and feedback. This will be deepened more in the theoretical framework.

As stated earlier, it is also not easy to integrate project methods into a learning process. Therefore, our starting point is to define the formative assessment approach, which is currently a method used in education. Reason to implement formative assessment is to create and monitor a clear path to reach the learning goals. The second step is to enrich this formative assessment approach with elements from the project management theory and establish a better adaptation and effectiveness of the formative assessment during execution of student projects. The widely available tools and methods of project management are, to our knowledge, not linked to formative assessment but can be an enrichment of current formative assessment techniques.

## 2 Theoretical embedding

### 2.1 Formative assessment

As motioned in Black & Wiliam (1998) the term formative assessment does not have an explicit meaning. The meaning of formative assessment is not restricted to one. In our research we use the same definition as used by Black & William (1998). "It is to be interpreted as encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged."

Formative assessment can be divided into different parts according to Black & William (2008). Firstly, to clarify and understand the learning goals and what is needed for success. Secondly, as a teacher

facilitating discussions, task and other activities that give proof of learning. Thirdly, giving feedback to improve learning. Fourthly, a part of formative assessment is creating an atmosphere where students act as learning sources for each other. Fifthly, activating students to promote ownership of own learning. All these aspects are part of valuable formative assessment which supports learning.

Table 2-1 Source: Black & William (2008)

	Where the learner is going	Where the learner is right now	How to get there
Teacher	1 Clarifying learning intentions and criteria for success	2 Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding	3 Providing feedback that moves learners forward
Peer	Understanding and sharing learning intentions and criteria for success	4 Activating students as instructional resources for one another	
Learner	Understanding learning intentions and criteria for success	5 Activating students as the owners of their own learning	

Each aspect can be useful during the execution of students' educational projects and can provide a possible improvement of their learning process.

- Clarifying learning intentions and criteria for success.**  
 In a situation where the student is doing a project, the goal of the project cannot always be the same as the learning goal. For example, using project setting in education is a good approach to discover how something works, either by yourself or in a group work. It should be clear to all stakeholders in a project (students and teachers) what the final intention would be. When is the student successful? By delivering the project or by showing that he reaches the learning goals. Therefore, in projects it is even more important to clarify from the beginning what the learning intentions are. This has a positive effect on skills and motivation of the student (Schunk, 1996).
- Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding.**  
 If during execution of the project formative assessments are part of the process, the outcomes of these assessments can be used to have a reflection of the learning process. Formative tests are important to trigger these kinds of discussions, therefore it is important to have the correct questions in the test (Mergendoller, Markham, Ravitz & Larmer, 2006).
- Feedback to improve learning.**  
 The conclusion of a formative assessment can be used to provide proper feedback during execution of the project. Feedback aims to evaluate the execution and aims for improvements in future phases or projects. As written in Hattie & Timperley (2007, p. 81). "Information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding". To be able to provide information on performance one must have insight in it. Since feedback must point out the gap between performance now and the desired performance. (Sadler, 1989).
- Activating students as instructional resource for one another.**  
 When the students are working in teams during the execution of the project, the feedback is mostly also discussed within the team. In this situation the project deliverables are team

efforts, but the learning goals are individual. During the discussions in the team, the team members can influence each other learning intentions.

- **Activating students as the owners of their own learning.**

Because working in a project is also working at more distance from the teacher. Students are forced to learn by themselves by exploring the subject independently or within a small team. This element of project education is already an activation of self-learning. Formative assessment is a manner to keep this learning process structured and helps the students to reach final learning goal.

The focus of this research will be mainly on the first three aspects of formative assessment. In project management the leader or manager will be the implementer of the process. In our case this is the teacher who leads the project. With the latter, we do not mean that other aspects are not important. However, we leave them out of scope at this moment and focus on the teacher in formative assessment. Later, every aspect will be explained in more detail.

In more recent research, formative assessment is described as an iterative process (Gulikers & Baartman, 2017). Also, in longer projects formative assessment should be a continuing process (Leahy, Lyon, Thompson & Wiliam, 2005). The focus of the research conducted by Gulikers & Baartman (2017) is on the role of the teacher in formative assessment. In the first phase the teacher clarifies expectations. Which is in line with the first identified aspect of formative assessment of Black and William. Phase two is about eliciting reactions from students. For example, by introducing interim tests. Moreover, Phase three is analysing the reactions from students and interpret them. The second and third phase correspond to the second aspect of Black and Wiliam. The fourth phase, communicating the results to students, in essence giving feedback is similar as aspect three of Black and William. Lastly improving the process in phase five, changing education and the way of learning and starting over again at the first phase.

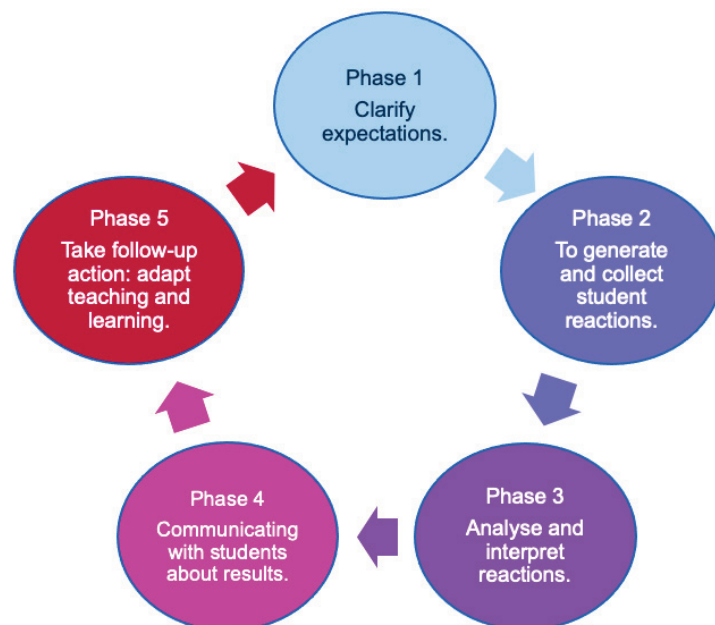


Figure 2-1 Formative evaluation cycle (translated from Dutch Research) (Gulikers & Baartman, 2017)

## 2.2 Project management

In the literature a project is often defined as following: “A project can be defined as a temporary organisation that is needed to produce a unique and predefined outcome or result at a prespecified time using predetermined resources.” (Duhig, & Atkins & Penzer, 2004). Based on this definition project management can be defined as a management environment that is created for the purpose of delivering one or more business products according to a specified business case. According to Heagney (2016), project management is “the planning scheduling and controlling of project activities to meet project objectives.”

These two definitions are clearly focused on efforts which are performed in a business-related environment and not directly related to a classroom situation. However, by comparing the situations you will find an overlap in definitions like “Predefined goal”, “temporary organisation or setting”, “delivering a goal”. These elements are also mentioned in formative assessments and are valid for projects conducted by students. It is therefore interesting to see if certain elements in the extensive theory and research for project management can contribute to an improvement of assessments in projects with students.

White & Fortune (2002) found a long list of factors which are critical for having a good execution of business projects. Not every factor can be suitable for education, several can be directly ‘translated’, while others might need a little tweaking. For example, clear goals/objectives, clear communication channels, effective monitoring and feedback, and a flexible approach to change are clearly the same in formative assessment. Some further stretched connections are support from senior management, in our case the teachers; effective team building/motivation; effective management of risk, in our case by the teachers; training provision, in our case some extra help on aspects of the project; and lastly, provision of planning and control systems, which would be the formative assessment cycle.

The same research found that over 95% of the respondents use at least one project management tool to improve project outcome. This indicates that tools can be useful to improve project success and also might have a benefit in project-based education. Project management tools are mainly helpful for beginners (Wells, 2012). Teachers are often not experienced in acting as project owner or project manager. Project management tools might help them acting in these roles.

## 3 The elaboration of the research questions

The research question for this research is defined as follows:

*How can formative assessment be applied to long-term projects in secondary school education to contribute to the process of deep learning among students?*

In answering this question, the following sub-questions should be answered:

1. How are formative assessments currently done in schools?
2. What kind of project management methodologies are currently used?
3. For which part of the findings found in research question one and two can formative assessment be beneficial?
4. Which instruments in the project management methodology can contribute to improving formative assessment during student projects?
5. What guidelines could be adopted by teachers who teach in long-term projects, based on the results of the interview conducted and the literature research, to improve formative assessment and thus contribute to deep learning?

## 4 The method of the research

The research consisted of three phases. The first phase was a needs and context analysis, based on qualitative interviews with teachers of computer science and O&O classes in the Netherlands. The second phase was literature study in which a basis for formative assessment was established based on already existing knowledge about formative assessment during student projects, the interviews and knowledge from the project management literature.

The third phase consisted of a proposal for a guideline on how formative assessment can best be used during student projects. This guideline was passed by teachers. Each phase will be described in more detail below.

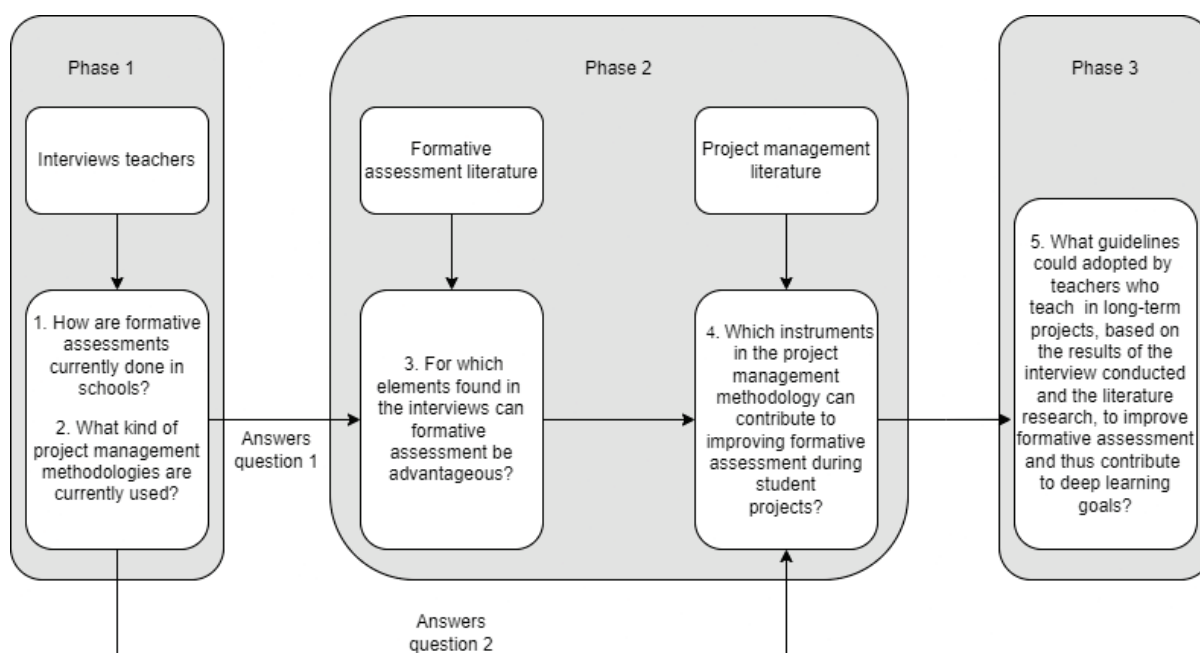


Figure 4-1 Overview of the research method

### 4.1 Phase 1: Needs & Context Analysis

During this phase, interviews were conducted with teachers from computers science and O&O courses, where long-term projects are used in their curriculum. The interviews provided qualitative data. An analysis of the data provided us with an overview of current practices used by the teachers. Based on this list an initial current approach for formative assessments was defined. This initial current approach provided us with an understanding of the current situation which will be input for the next phase.

#### 4.1.1 Target group

The target group of our research were teachers from classes in the HAVO/VWO in which various long-term projects are used as means of teaching. There was focused on computer science classes and O&O classes, because in these courses project education is part of the curriculum in the Netherlands. Four O&O teachers and two computer science teachers were interviewed. Interviews were conducted with 6 experienced teachers (3 or more years in projects teaching).

#### 4.1.2 Materials

There was made use of semi structured interviews. The Guide of Kallio, Pietilä, Johnson, & Kangasniemi (2016) was followed to create an interview guide. So, the appropriateness of semi-structured interviews was assessed and found valid. Semi-structured interviews gave the possibility to dive deeper into the matter and deviated a little when appropriate. The interview guide can be found in appendix 1. In the analysis phase there was made use of Trello. Trello is a software programme that allows grouping and organising different fragments of the interview.

#### 4.1.3 Procedure

During this phase, an extensive semi-structured interview was conducted to identify potentially suitable indicators and methods used for formative assessments in the classroom. On average each interview took 40 minutes and during these interviews the interview guide was used. The first thing done for creating the interview guide was gaining understanding about the subject by the researchers. The introduction and the theoretical framework were created to gain knowledge and seek understanding. After that the first version of the interview guide was created. In which literature formed a basis for the different questions. After that the guide was pilot tested. Only due to the limited time to gather data the pilot interview was added to the dataset. The final interview guide with questions and sub questions can be found in the appendix. In the interviews the guide was used and as is normal practise in semi structured interview sometimes questions were asked not in the guide if this was needed to get a better understanding or something interesting came up. After the interviews were conducted, they were transcribed.

#### 4.1.4 Analysis

First, researchers familiarized themselves with the data. Next, quotes were labelled as possible answers to research question one or question two. This identified the first possible themes. The quotes were placed in the themes. Then the themes were evaluated and modified by the researchers. There was discussion until there was consensus and all the quotes were in the correct theme. The themes were labelled as follows:

- Learning goals
- Reflecting
- Formative conversations
- Peer feedback
- Process improvements
- SCRUM/Waterfall
- Overseeing amount of work
- Differences upper and lower classes

Here, a thematic analysis was performed as described by Braun & Clarke (2006). Conclusions from the themes were written and checked by both researchers. These collected perceptions were reported and formed the basis for the next phase of our research, the search for improvements. Phase two provided a clear generic overview of the current situation regarding formative assessment and the use of project management methods during the implementation of student projects. In appendix 2 a selection of the analyses is presented.

## 4.2 Phase 2: Literature research.

Phase 2 included a literature review that focused on two topics. The first study focused on knowledge generation in formative assessment. Especially during student projects. The findings from the literature were evaluated based on the findings from the first phase. The second research step in phase 2 focused on existing project methods used in commercial settings. The findings of project

management methods found during the interview phase could also exist in commercial projects. During this part of the research, the goal was to evaluate how existing methods deal with these issues and what tools have been developed that could be useful in student projects. The result of this phase was the basis for a formative assessment guideline, based on existing project management tools.

#### 4.2.1 Materials

Different search engines and literature databases like google scholar were used to find appropriate literature. See the bibliography for the full list of material used during this phase.

#### 4.2.2 Procedure

Based on the results of Phase 1, a list of areas of focus was developed. The areas of concern emerged from the interviews. Based on this list, a literature review was conducted to determine how best to address the issues through formative assessment. Proven project methodologies were then examined to understand how these issues are addressed in commercial projects and what tools have been developed to address them. The result of this phase provided the basis for a formative assessment guideline that can be applied in a classroom setting.

#### 4.2.3 Analysis

During the literature review, the focus was on the most common groups of project management methods: Iterative project management methods (e.g., Agile and SCRUM), Waterfall methods (e.g., PRINCEII and PMI) and more statistical methods (e.g., LEAN, KANBAN and 6SIGMA). The focus was on finding solutions within each group rather than within each individual methodology. The reason for this was that the methods within the group are usually similar and/or complementary. It is important to note that one group does not exclude the other. Usually, companies use tools from multiple groups to keep their projects manageable.

### 4.3 Phase 3: Provide guidelines how formative assessment can be implemented.

Based on the results of phase 2, a practical guideline was formulated by the researchers for the implementation of formative assessment during student projects. The different project management tools were adapted to fit the school environment and level. These guidelines were presented to teachers. The feedback of the teachers was collected in the form of an evaluation form. The feedback of the teachers on the guidelines is reported in the research.

#### 4.3.1 Target group

The target group that was used in this phase of the research were a convenience sample. All teachers interviewed had some experience in teaching long term projects in either O&O and Software science.

#### 4.3.2 Materials

An evaluation form was used. The form consisted of four open questions to get an indication about the teachers' thoughts about the guidelines. As well as possibilities for further improvements. The form can be found in appendix 4.

#### 4.3.3 Procedure

Prior to the interview, an explanation of the research process and how it led to these guidelines was first provided as an introduction. Then, infographics were presented to the teachers, which can be found in appendix 3. The infographics contained a summary of the guidelines to explain these guidelines to the teachers in a limited amount of time. The teachers were allowed to ask questions



to clarify ambiguities. Then they filled in the evaluation form. The forms were collected and are included in this study.

#### 4.3.4 Analysis

The researchers discussed the results. The answers were reported per question in a summarised manner.

## 5 Results

### 5.1 Phase 1: Needs & Context Analysis

Based on the transcripts of these interviews the following outcomes become clear. The outcomes are categorizing per research question. In appendix 2 the qualitative data obtained from the interviews are presented.

#### 5.1.1 How are formative assessments currently done in schools?

From the results of the interviews, the following main topics could be identified:

- **Individual reflection on the individual skills and knowledge is performed at the beginning mostly to form goals and at the end of projects to reflect on what is learned.**

Most of the teachers indicated that reflection activities were performed by students themselves at the beginning of a project to enable them to define the learning goals, so-called soft skills. This was sometimes done in a questionnaire to be filled in or a personal development plan for the senior students. During the execution, there were sometimes predefined moments as well to perform a reflection activity but mostly initiated by the teacher. As indicated by this quotation: *“After each project, we try to reflect on it with the students. First they look at how they have grown and then we as teachers look at it again. Depending on the project and the situation, we then talk about it in the group or individually.”*

The majority of the teachers indicated that at the end of the project a reflection exercise was done by the students. The general opinion of all interviewees was those reflections cannot be graded, that was for most the reason they see it as formative. Theoretically, a reflection report helps the student to provide insight about the level of growth in soft skills during the projects. The idea of this formative assessment method is that students are activated to be owners of their own learning which literature described to be part of formative assessment. Most of the teachers pointed out that this was not working optimally in practice at the end of a project since students were not invested. Students were not very likely to see the value of the reflection. As one teacher said: *“Works great, but not really.”*

- **Majority of the interviewed teachers indicated that most learning goals are not specifically integrated into the project. However, they can be chosen by students and fitted in every project.** This means for most teachers that there were several competencies that must be worked on. Except for one computer science teacher this was not the case. However, every student can develop themselves in a different competence, so the learning goals were not the same for every student. As this teacher indicated *“Then halfway through the project we look back and see, Oh, what is this student specifically working on now?”* This makes that the projects goals mostly did not include specific learning goals. The learning goals could be defined for every project since most competencies are focused on the process (e.g., skills). Most of the time students must have chosen their learning goal for the project as indicated before. This finding is important for the clarifying learning goals as part of formative assessment.

- **Feedback conversations were used by all teachers.**  
 Most teachers had group conversations with the students of a specific project. During these conversations, they tried to get more information. Moreover, they provided the students with feedback. They all have different names for these conversations. These feedback conversations can be projected on in the formative evaluation process. Phase 2 till 4 of the formative evaluation cycle has been gone through during the conversation. However, most teachers did not see it as formative evaluation, but as normal practice. One of the teachers explained how he plans the feedback conversations: *"In the meantime, you have coaching sessions that you fill in depending on how much time you have and how things are going. There is always room for improvement. But yes, depending on the size of the group ... these are ad hoc, they are not fixed at a particular time"*
- **Peer feedback was used to get more information about the students.**  
 Peer feedback was used by all O&O teachers to get more information about the students. Next to that teacher indicated that this gives a new view on the functioning of the students within the team. Mostly the teachers provided templates, with for example dividing a finite number of points, among the team to get the conversation started. They also must argue why they divide the points in that way. As this teacher explained *"Then I have them give marks, not a final mark in the absolute sense, but as an example of weighting factors, a group of 4. They get 11 points that they have to assign to each other."* The forms are used to get more insight in the group collaboration. For the group itself as well as for the teacher. No summative assessment comes out of these divisions.
- **In the higher classes a go/no go moment was often used on the project plan.**  
 Since the lower O&O classes were given a project with a structure, it has already been planned for them. The higher classes had to come up with it themselves. To have an extra check, the project plan had to be handed in and is checked by the teacher. If not, it must be revised. It can also be a conditional go moment. No grade is attached to the moment only feedback. As explained by a participant: *"In principle, once the project plan is drawn up, they get a "go/no go" moment. This is not a hard deadline. But more of an update on how the project is progressing. Basically, to protect them from coming up with something nice and then finding out at the end that it is not a solution to the problem at all."*
- **Process improvements of formative testing during projects were not embedded in the process by any of the interviewed teachers.**  
 Formative assessment and reflection activities were not part of the continuous improvement cycle. Teachers pointed out that they did not have the time or see the need to think about these formative activities. Changes were usually triggered by requests from the school management. If improvements or changes were made, they were usually focused on the moment during the project when formative tests were carried out. The teachers are of course always involved with improving their practice, but they do not focus on formative evaluation as a consciously used tool. For example: *"No, in principle those steps are quite the steps. Only perhaps the content of the lesson that you sometimes adjust. If you notice that certain problems are more classical."* However, for example part of they are reflecting on what needs to be improved. *"What I do notice is that we don't keep doing that [reflecting] every sprint... I remember very well the reaction of yes sir, if we are going to do this every sprint, we will lose so much time that we can also use it to carry out a task. So you see that you have to be a bit more flexible in that respect, ...."*

To summarise the above points and answer the question, the following can be concluded:

1. Most of the teachers interviewed indicated that learning objectives were outside the project rather than as an integrated part of it. This is important since one of the steps in the formative evaluation cycle is 'clarify expectations'.
2. This brings us to the following finding regarding how learning objectives were usually established. Reflection on the execution of projects was done by the student at the beginning of the project according to the O&O teacher and at the end of projects according to all teachers. Students had to indicate what they were working on and what they had worked on. In this way, the learning objectives were part of the formative assessment process. In practice, this did not work optimally according to most teachers. The reflection activity, for instance, was not taken seriously by the students. They focused on the project itself.
3. None of the teachers had a fully structured approach to conducting feedback conversations in which they went through part of the formative evaluation cycle in one feedback conversation.
4. Formative evaluation processes during projects were not fully embedded by any of the teachers interviewed. In the higher classes, a formative go/no go moment was often applied. In the lower classes, this was not necessary because the project was more set out for them.
5. Peer feedback was often done with other reflections at the end of the project. This had disadvantages that have already been described.

#### 5.1.2 What kind of project management methodologies are currently used?

To clarify, project management methods are sometimes used as part of the formative assessment process. They could therefore also be described in the section above. However, the decision was made to group all the findings on formative assessment together.

- **Project methodologies like SCRUM and Waterfall were not fully embedded in the education process.**  
All respondents mentioned not using these methods fully according to the books. By one teacher no methods were used and sometimes some elements were used in certain projects. For example: *"Really scrummed with a scrum master. I have not done that. I did try something in the junior class with a sort of scrum light. They took an a3 and there are just some post-it's with their tasks. All the tasks that still need to be done or that they are working on and have done in 3 columns and then with post-its from one side to the other."*
- **Waterfall methods were easier to implement but not used as project management tool but as reporting tool.**  
Teachers using the waterfall method indicated that the project plan was more of an implementation report and was delivered as a final report, rather than being used as a control document during project execution. The plan was a start of a report and was just filled in later and not used to keep the planning. These teachers indicated that because of this, the implementation of a waterfall method took less time than the implementation of SCRUM.
- **SCRUM was taking too much time during the lessons therefor not suitable to use always.**  
Although SCRUM was theoretically pointed as a possible way of executing projects, it was not fully implemented due to the fact students could spend limited time per week on the project. Half of teachers themselves indicated their students use SCRUM. However, the implementation were only parts of the total. As the teacher who did not use, indicated: *"In the end, the projects are so simple here that it's quite heavy to have to do all those steps over*

*and over again, and the students only experience it as ballast.*" Other teacher's who used parts of methods had similar comments. The SCRUM method was based on unlimited time availability during execution of a project. During project execution, the rule also applied: first complete the task, then move on to the next. This way of working conflicted with the way schools are organised. Scrum in its original form did not fit in a school environment.

- **SCRUM boards are used as list of tasks to be executed and gives information to the teacher.**

SCRUM boards were used by half of the teachers. These boards were mostly to track the progress of the project for the students themselves. The board also provided information of progress to the teacher. Also, teachers indicated that there were better tools to keep track of the execution. Like sharing working documents with the teacher. *"Basically, when I walk past each group. I also say, for a coaching session, I'll start the conversation based on what I see on the scrum board. Because if it's good, everything they're working on is visible on the scrum board, but we also let them put the learning goals up there. So basically, it's a kind of learning goals that are visible to that group."*, one teacher said. The quoted teacher was the only one who used the SCRUM board to also put the learning goals on. The learning goals were put on the board in a separate field to have a faster view of what the student wanted to work on in this project. The learning goals post-it cards were used as a starting point for a feedback conversation. Otherwise, it was hard to remember what every student wanted to accomplish when you were teaching a lot of students.

- **The decision which method to be used was done by the students themselves as part of learning project management skills.**

O&O teachers indicated that explanation of the several project management methods was part of the curriculum. Students were mostly given free hand in selecting the best way of working for them. In the lower classes the tools like SCRUM were explained and used. In the higher classes they had more freedom in selecting tools. Teachers see different approaches taken by the students in the higher classes when they left it up to students. Some used the explained tools the way they were thought. Other students took parts of the tool without even knowing they were. Other students did project planning and management in their own way.

- **Students had difficulties to plan work during the project. It was difficult for them to understand the amount of work each activity required.**

Most teachers indicated that students on this age had not the ability to estimate the hours to be spend for executing tasks. Because they were not skilled in estimating time, it was very difficult for them to write a project plan beforehand or execute scrum sessions. Teachers also indicated that the teaching time was insufficient for teaching them in making correct estimations. They preferred to use the learn by failure approach. As one teacher explained: *"You have those teachers where scrum is sacred. But what we noticed at the beginning is that students, and certainly first-year students, find it very difficult to say to them: 'This is the project, and this is what you are going to work on for a few months. Because it is so far for them. Actually, what I find useful about the scrum board is that they learn to oversee the project. What is actually involved? How much time will it take?"*

- **A good approach according to the teachers was to split large projects into mini projects with smaller end products.**

To overcome the estimations problem and to keep the students focused, the computer science teachers and an O&O teacher indicated that creating moments during the project in which students delivered half end-products, was a good way of executing project by

students. Splitting the project into mini projects was often done by the teacher. Like this teacher said: *"What we often do is divide the project into sort of four large chunks. And then start with each chapter, actually at the beginning of the preliminary research chapter. As soon as they're done with that, they make notes and when they're done, they move on to the next one."*

The students used project management methodologies. This was mainly to help them plan the tasks and teach the project management skills. Usually, they were not used extensively by the teachers as formative assessment tools. However, SCRUM was used by some teachers to see what the students are doing at that moment. Waterfall techniques were seen more as a tool for reporting at the end.

## 5.2 Phase 2: Literature research

### 5.2.1 Which elements found in the analysis can be ensured by formative assessment?

As a result of the interviews, it can be concluded that there is a need for improvement during the execution of the projects in the classroom. The needs could be linked with formative assessment literature. Some examples were added to make the statements clearer. In summary, the following points of attention described below came out of the interviews.

#### *Focus of product and learning goal*

The focus should be on both product and learning objectives. However, the students focus mainly on the product goal, while the teacher is mainly interested in the learning goal.

- During implementation, the end goal should be kept in mind and the learner should be motivated to complete the project to reach the learning goals. Keep in mind that learning goals can be different from project goals, and both need to be supported.
- Clarify the expectations of the students. So that the learners know what the learning intentions and the criteria for success are. This is an important step identified by formative evaluation literature (Black & William, 2008 ; Gulikers & Baartman, 2017). This can be done in different ways. For example, formulating questions with the students that can be answered at the end of the lesson or lesson series. Show examples of what is expected of them or the use of a rubric to show students what is expected of them. However, there must be a balance between too narrow and too loose goals. These goals should be communicated at more moments and in different ways.

#### *Reflection*

Self-Reflection to learn from the experiences is what is essential for learning in projects. Students however see this as a side product that needs to be taken care of.

- Promote self-evaluation by the students during the implementation and help them with the reflection exercises in a way that is valuable for the students. Black and William (2008) describe it as valuable in the formative assessment process when students take ownership of their own learning. This can be done by creating learning goals that are aimed at participation, social norm, or cooperation. Next to that there should be given a structure for students to for self-assessment (Gulikers & Baartman, 2017).
- Supporting students to be feedback providers for one and other can be a valuable part of the formative evaluation process (Black & William, 2008). This can again be achieved by creating a structure for peer-assessment. More effective teachers do give more structure in

the peer-feedback process (Gulikers & Baartman, 2017).

### *Feedback*

Reporting to the "client" and getting feedback is already part of the process in most places. The teacher is usually the active figure in the process. More clarity is needed by providing a better guide to when and what needs to be reported.

- Support is needed for the teacher regarding the reporting process on the status of the implementation of the project by the students both during the implementation of the project and in the form of a final work. In O&O, this can also be the actual client. This should be a continuous process in student projects (Leahy et al, 2005).
- Provide support for the teacher in giving qualitative feedback by giving the teacher a structure. What is important in phases 3 and 4 of the formative evaluation process by Gulikers & Baartman, (2017) which are first interpreting the results and then giving feedback. The feedback should be specific and descriptive instead of judging and summative. The feedback should also be coupled to the learning goals. The feedback should not be too specific especially if the aim is to have self-regulated learning by students. It shows the importance of the formulated learning goals (Gulikers & Baartman, 2017).

### *Planning work*

Planning work is the main reason why students themselves use the tool. Students do not always see the benefit however teacher indicate it is helpful for them. Next to that it can give the teacher insight in how students are planning the work and where they are working on.

In short, the following points:

- As a teacher to gain a good understanding of the outstanding work and to get a feeling about the number of hours to be spend by the students on which task. In the formative evaluation cycle of Gulikers & Baartman (2017) this is phase 2 gathering student reactions and information. The information can be used by the teacher as a start for feedback. There should be methods in place that gather information that are coupled to the learning goal. The information gathering method should be focused on problems that are common. More effective teachers have more methods in their repertoire. The methods can be formal as well as informal. For example, asking questions but a more student steered conversation is better (Gulikers & Baartman, 2017).
- To execute the project in smaller steps to help the students with planning of the work. Most students at this age can not foresee planning of work which is more than two or three weeks ahead.
- To help to execute the work besides all other schoolwork. Remember students at high school have about 7 up to 10 subjects at the same time.
- To support the idea, the student can only work at the project during the class and some limited time at home.

#### 5.2.2 Which instruments in the project management methodology can contribute to improving formative assessment during student projects?

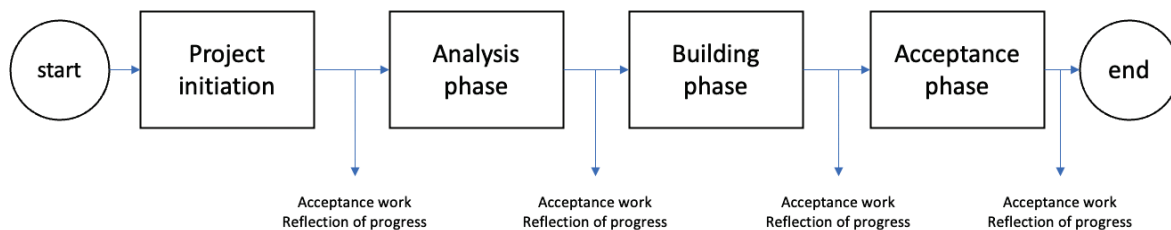
Literature review indicates that three groups of project management methods can be identified. The following section provides a brief description of each group, followed by the differences between these groups in terms of work planning, focus on goals, reflection, and feedback. Although there is no limitation in the literature on the number of groups of project management methods, project management methods are generally divided into these three groups (Hrablik Chovanova 2020, Mkoba 2017, Svejdarova S., 2019):

- Waterfall methods, which includes PMBOK and Prince2
- Iterative methods which include:
  - a. Lean-Kanban
  - b. Agile-Scrum

The following paragraphs will provide more details about each group and how they differ in performance. It is important to understand that there are many variants for each group, in this study it was decided to observe the original constrains for each group to avoid complexity in the result.

#### *Waterfall methods (PMBOK, Prince2)*

This group of methods is based on the traditional way of carrying out a project (Meredith, 1989). The emphasis is on the process of achieving an end goal within the preconditions set by the project owner. It is important that the end goal is clear at an early stage of the project. The activities are also organised in such a way as to facilitate this approach. Figure 5-1 shows a common approach for a waterfall project. The project is divided into phases, and the output of each phase is the input for the next phase. During the transition from one phase to the next, reflection often takes place with the members of the project team to ensure that the project has reached its end goal.



*Figure 5-1 Waterfall approach*

Although the waterfall method is considered a traditional approach, it is still a very common approach for carrying out projects and in many cases, it is also considered an effective approach. The disadvantage of this approach is that when the output of the previous phase is not sufficient to complete the next phase, unexpected extra work is needed to solve this problem. The advantage of this approach is the clear path to the end of the project, which is often defined at the beginning of the project. By focusing on the process, it is clear to the project members during the execution of the project when the project will reach its final goal.

#### *Lean methods (Lean-KANBAN)*

The lean methods were originally developed within the company Toyota to create a flexible way of working in projects. Today, this method is still used in many companies. Important here is that projects are not organised in well-defined phases, but the activities are controlled by a so-called "work in progress" list (WIP). On this list, activities are placed that must be carried out by the project team. These activities are assessed in terms of expected spending time and importance. Based on the available work time, the list is capped at this maximum time. For example, a team has 5 hours to spend for one week. The project takes 10 weeks, so the total time spent on the activities on the 'work in progress' list is not more than 50 hours. During the project, each team member chooses an activity from the "work in progress" list that they think can be completed within their allocated time. Members are free to choose the activities. When an activity is completed, it must be immediately accepted by the customer as completed, otherwise the activity is not completed, and the team member cannot start with the next activity. Putting activities on hold is not allowed.

New items can be added to the 'Work in progress' when the limit allows to do it. There are no daily meetings about feedback and progress, the team members are only working with the 'work in progress' list and their mutual goal is to empty this list as soon as possible.

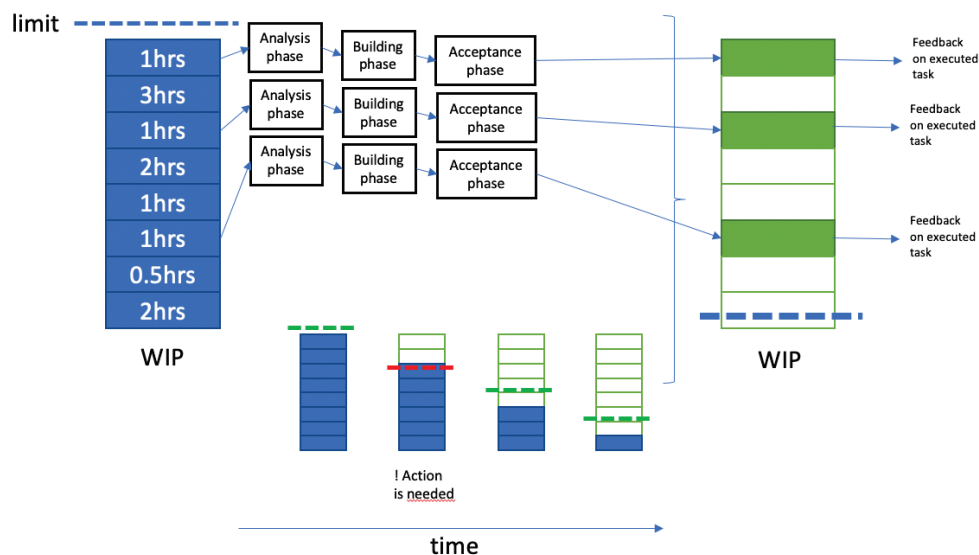


Figure 5-2 Kanban approach, working with a dynamic 'work in progress' list.

Although the Lean methods are more flexible than the waterfall methods during implementation, these methods still require a plan at the beginning on how to reach the end goals. An initial WIP must be defined, and the team must be confident that this WIP is good enough to reach the final goal.

#### Agile methods (Agile-SCRUM)

Agile methods (Schwaber, 1997) are emerging in many project environments. It was defined in 2001 by a group of software developers with the aim of improving projects in the software industry (Agilealliance 2001). Agile approach was a response to the fact that not all requirements are clear at the beginning of the projects in the IT industry and therefore project based on waterfall methods had difficulties to keep the projects under control. Although Agile is partly based on the experiences of the Kanban approach, there are differences:

- In Agile projects, teams work with timeboxed sprints. Kanban teams do not work with sprints.
- Agile projects have clearly defined roles within the team. Within Kanban teams there are no defined roles.
- A Kanban board is used throughout the project, an Agile board is used during the sprint and is cleaned up and recycled after each sprint.
- Kanban boards are more flexible regarding timing and order of carrying out tasks.

A commonly used Agile approach is SCRUM which is based on sprints (Sutherland, 2014). Sprints are time-delimited periods in which a team must deliver various tasks based on a so-called sprint backlog list. After each sprint, a reflection takes place based on the results of the sprint. A new sprint backlog list is defined for the next sprint. At various times during a sprint, a scrum master asks the team three questions:

1. What did you do yesterday?
2. What are you working on today?



### 3. Do you have anything impeding your progress?

The goal of the team is to complete the sprint with all tasks in the sprint backlog within the given time. In addition to the sprint backlog, there is also a project backlog with all the tasks that 'could' be done before the project is classified to be finished and meet the vision. This backlog list is managed by the project owner, and it is his decision to prioritise the tasks on this list. It is also his responsibility to determine that the project has reached its goal and can be stopped.

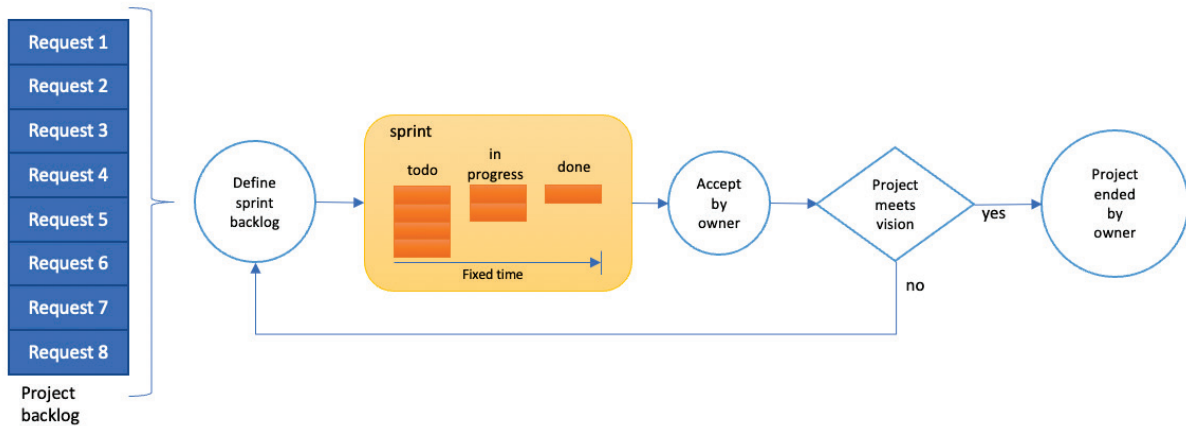


Figure 5-3 Agile approach, working with sprints

The advantage but also disadvantage of Agile is the flexibility during project execution. In fact, except for the sprint, everything is flexible. The project owner can change the project backlog during the project and a clear end date is not defined during an Agile project. The project is finished when the project owner says so. Unlike the other two methods, Agile is not focused on the path to the end. It is strictly focused on the work within a sprint. This can lead to a not so efficient way of working and puts the responsibility on the project owner to make clear requests that lead to achieving the project goals in as few sprints as possible.

In complex projects where it is difficult to define a path to the end goal or when the requirements are not or difficult to define at the beginning of the project, Agile is considered a good approach for such projects. In case the path to the end goal, the goals and the requirements are clear at the beginning of the project, Waterfall or Lean methods should be considered.

#### 5.2.3 Selecting the best method

When selecting the best method for a project, Stacey defined a complexity matrix. This matrix can be helpful in selecting the right method (Stacey, R (2002)). Figure 5-4 shows the complexity matrix based on the following two dimensions:

- Is it clear what needs to be done?
- Is it clear how it will be done?

Based on the answers to these questions, a guideline can be given for the preference of the suitable method. When both questions are very clear, a waterfall method will be the best option (green area). When one or both questions are not clear, an Agile method with Scrum will be the recommended method (orange). For the yellow area between the two opposites, it would be good to use a simpler approach by using a Lean method with Kanban. The latter gives more flexibility during implementation, and the team is expected to be able to manage the risk themselves.

### Stacey Complexity Matrix

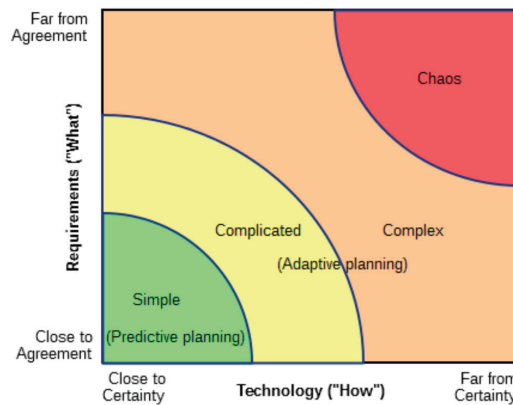


Figure 5-4 Stacey Complexity Matrix (Stacey 2002)

#### 5.2.4 Focus on product and learning goal

The way in which the different methods control the achievement of the project goals is different. Waterfall and Lean are focused on formulating a good goal from the beginning and have clear moments during the execution of the project to test the project against the goal. Agile projects are flexible in defining the project goal by having a clear focus on sprint goals and a global vision of the project goal.

Table 5-1 Difference in the approach of focus on project goals

Waterfall	Lean-Kanban	Agile-Scrum
Objectives are formulated at the beginning of the project. After each phase, there is an evaluation moment to see if the project can reach its goal within the given constraints.	The setting of goals is done with the help of a list of outstanding work to be carried out. A continuous evaluation of the outstanding work in relation to the limit ensures that the goal is reached at the end within the project's preconditions.	The starting point for Agile projects is that the project goals may not be clear at the beginning. A 'vision' of the project owner is defined as a direction of the product to be delivered and can be seen as the project goal. The project team focuses on achieving smaller goals during sprints and evaluates at the end of the sprint whether the sprint goals have been achieved. As long as the work added to the sprints contributes to the project vision, it is assumed that at some point the goal of the 'vision' will be achieved.

When translated into student projects with formative assessment of the path to achieving the project goals and learning objectives, it can be translated as follows:

- Student projects based on Waterfall**  
 After each phase of the project, a formative assessment of the learning objectives achieved can be carried out. The output of this assessment can be used in the next phase. The team

works with the knowledge until the end of the project when the project goals and learning goals are achieved.

- **Student projects based on Lean-Kanban**

Within Lean-Kanban, the WIP (work in progress) is the indication of how far the team has come in reaching its goals. The goal is to have this list empty at the end of the project. During the implementation, the teacher can check off tasks on this list. This is the moment to give formative feedback on the work done and whether the learning goals have been achieved.

- **Student project based on Agile-Scrum**

Within an Agile-based project, the formative assessment moment is just after the completion of a sprint. This is the moment to check how far the team is in reaching the 'vision' of the project. Note that the difference with Waterfall is that the formative outcome is not necessarily needed to start the next sprint. After each sprint, it is therefore possible to determine whether there is progress in achieving the learning objectives.

### 5.2.5 Reflection

Reflection activities take place during all three types of projects. The moment of reflection differs per method.

*Table 5-2 Difference in the approach of reflections with the team members*

<b>Waterfall</b>	<b>Lean-Kanban</b>	<b>Agile-Scrum</b>
Reflection takes place at two moments. After each phase and at the request of the project manager during a phase. Waterfall projects focus on the process, which is why it is important to remove all obstacles that may arise during execution as quickly as possible.	Reflection takes place after each deliverable with the specialist and the project owner. Also during the execution when necessary. A project member can ask to stop the work for a reflection to improve the way of working.	Agile based project has a moment called "retrospective meeting". During these meetings, each member of the team is asked how the project can be improved. This is a very open question, and all topics can be discussed. Retrospective meetings are usually held at the end of a sprint.  The second moment is during the start of the day meeting. During this meeting, the scrum master asks the team if there are any issues that are hindering the team from delivering the sprint.

Applied to student projects with formative assessment on the reflection of project implementation, it can be formulated as follows:

- **Student projects based on Waterfall**

As with the evaluation of the degree to which the goals have been achieved, the time to hold a reflection with the team is also between the phases of the project or at the very end of the project.

- **Student projects based on Lean-Kanban**

Within Lean-Kanban, this is more of an on-demand activity. When the teacher (project owner) or students find it necessary to have a reflection with the team, the project will be put on hold temporarily.

- **Student project based on Agile-Scrum**

Reflection is done during the retrospective meeting. These meetings are sometimes held after an important sprint. For an Agile project with four sprints of 2 weeks each. It is good to hold one just after the second sprint and one after the fourth sprint. Within Agile, it is common to do a peer-reflection, this can also be done with students.

### 5.2.6 Feedback

Feedback from the project owner is important in all types of projects. The owner must accept the work and ultimately the project.

*Table 5-3 Difference in the approach of providing feedback*

<b>Waterfall</b>	<b>Lean-Kanban</b>	<b>Agile-Scrum</b>
Waterfall projects have regular meetings with the owner. At these meetings, the owner signs off on the work completed by the phases and gives permission to continue. In the event that the project cannot be completed within the preconditions, the project owner must approve the deviation. This means that the preconditions or the workload must be changed.	The project owner provides feedback on any work completed by the team during the project. Once the work has been positively evaluated, the task can be removed from the "Work in Progress" list.	The project owner gives feedback on the result of the sprint during the retrospective meetings.

Applied to student projects with formative assessment of feedback on the outcome of the project in general, it can be formulated as follows:

- **Student projects based on Waterfall**

The "client" or teacher can give feedback on the work done after each phase and at the end of the project. The best way is to use standard key indicators such as time spent and fulfilment of expectations. The expectations are related to the learning goals.

- **Student projects based on Lean-Kanban**

Lean-Kanban only knows a moment when a task is completed, or at the end of the project when the WIP list should be empty. During the evaluation of the task, key indicators can be used such as time spent, quality of work. A standard rubric can be used each time a task is delivered. When a task is delivered it can be compared to the rubric and checked if learning goals are reached. It is not necessary that formative evaluation is done by the teacher, it can also be done by fellow learners.

- **Student project based on Agile-Scrum**

Feedback can be given after each sprint. Sprints should deliver work packages that should be

final products for the 'customer'. Feedback can be given by the 'client' on the basis of the 'vision' document. Does the sprint package meet the requirements outlined in the 'vision' document?

### 5.2.7 Planning work

The three methods differ significantly regarding the planning of the work. The planning takes place at different moments in the project cycle. Table 5-4 shows the difference between the three methods.

Table 5-4 Difference in the approach of planning work to be done.

Waterfall	Lean-Kanban	Agile-Scrum
The planning exercise takes place before each phase during the project. The output of each phase is the input for work to be done in the next phase.	Within Lean-Kanban, the focus on the work to be done is one of the most important key indicators of the project. The work in progress list is managed throughout the project. The team continuously manages whether the remaining work can be done until the end of the project.	Within Agile-Scrum there is only management focus on the work that must be done within the sprint. All the work in a sprint must be completed within the sprint period. outstanding work in the project backlog is not addressed, so there is little control over the number of sprints required to complete the project.

Applied to student projects with formative assessment, it can be formulated as follows:

- Student projects based on Waterfall**

Before the student team starts a project, the team writes a project plan with a schedule, for example in the form of a Gantt chart. This must be assessed by the teacher for feasibility. After each phase, the team adapts this diagram, and the teacher assesses the new version. During the formative assessment, the emphasis should be on the solution to make the project planning fit again when the project risks getting out of control. The team must come up with a plan (exception plan) that must be assessed by the teacher for feasibility.
- Student projects based on Lean-Kanban**

At set times during the execution of the student project, the teacher, together with the team, assesses whether the WIP is still under the limit of the maximum number of hours to be spent until the end. If the maximum number of hours is lower than the number of hours to be spent, an adjustment must take place. During the formative evaluation the focus should also be on the solution. What ideas does the team bring to the table to get the WIP under the limit and are they feasible?
- Student project based on Agile-Scrum**

Formative planning assessment for Agile student projects is possible at the time when the planning of a sprint is discussed within the team. This happens during the start-of-the-day meetings. During these meetings, the team discusses the planning of the tasks for this sprint. The assessment focuses on how the team members discuss the plan and how they tackle problems during the sprint. During the formative assessment, the focus is on the group discussion of how the team solves the planning problems during the sprint.

## 5.3 Phase 3: Guidelines for projects with formative assessments

*What guidelines could be adopted by teachers who teach in long-term projects, based on the results of the interview conducted and the literature research, to improve formative assessment and thus contribute to deep learning?*

### 5.3.1 Step 1 Selecting proper approach

Before starting a student project, a decision must be made as to which type of project is best for the given situation. Although the boundaries cannot be strictly followed, it is advisable to answer the following questions before deciding on a project type.

A first important question is how clear the path to achieving the (learning) goals is and how clear the goals themselves are (Stacey 2002).

- Is it clear for teachers what needs to be done?
- Is it clear for teachers how it will be done?
- Is it clear for students what needs to be done?
- Is it clear for students how it will be done?

When it is less clear what needs to be done, an Agile-Scrum method is more suitable. If the path to the goal is clear at the beginning of the project, a waterfall method is more suitable. In between, a Lean-Kanban method can be useful.

The second question to consider is how big the project team will be. Agile-Scrum in particular requires several dedicated roles during implementation, so it also requires a fairly large team (between 5 and 10 people). A small team will see the process with different roles as a bureaucratic obstacle for achieving the goals.

- How big are the teams?

The third question to consider is the available time that can be spent. Especially in student projects, it is important to recognise the total time that a student must spend in order to fully fulfil the objectives. When time is limited, Lean-Kanban, for example, is a good solution. This is because this method is based on controlling the time to be spent.

- How many study hours (SLU) in total are available?

The following table provides a suggested response to the questions and offers advice on which method to use for a student project. The answer to each question provides advice on which project method to propose. For example, if the answer to the first question is 'very unclear'. The suggested method is then the Agile-Scrum method. When each question has been completed, an advice becomes clear. However, sometimes there may be contradictory answers. In that case, the teacher must make a considered decision. In other words, give priority to questions that the teacher thinks are more important for this project. To emphasise again that there is no one right answer. Only certain project methods are more appropriate for a given project. It could just as well be that two methods would be suitable for a certain project.

Table 5-5 Approach for selecting the best project method selection.

Question	Left border	Advice			Right border
Is it clear for teachers what needs to be done?	Very clear	W	L	A	Very unclear
Is it clear for teachers how it will be done?	Very clear	W	L	A	Very unclear
Is it clear for students what needs to be done?	Very clear	W	L	A	Very unclear
Is it clear for students how it will be done?	Very clear	W	L	A	Very unclear
How big are the teams?	Small	W/L	W/L	A	>= 5
How many study hours in total are available?	<10	L	W/L	W/A	>20

W = Waterfall, L = Lean-Kanban, A = Agile-Scrum

### 5.3.2 Step 2 Execution with formative assessments

After the selection of the project methodology, formative assessments can be carried out during the implementation of these projects. It is advisable to inform the project teams when each formative assessment will be conducted.

### 5.3.3 Formative assessment during a Waterfall project

When a waterfall method is chosen, formative assessments are usually carried out during the transition to the next phase.

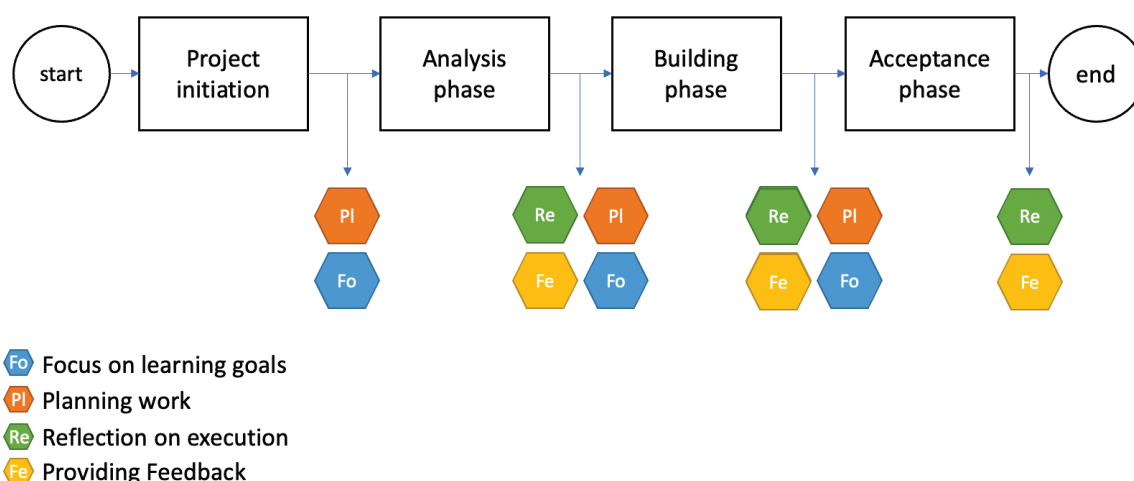


Figure 5-5 Formative assessment moments during a waterfall project.

### Initiation phase

The first moment is at the end of the initiation phase of the project. During this moment, the emphasis is on planning the work in the next phase, focusing on the goals and learning objectives of the project divided into phases. The following questions and possible approaches are recommended:

- **Focus on product and learning goal**

- Are the project goals and connected learning goals clear?
- Is in general clear what the goal is for each stage?
- Is in detail clear what the contribution of the project goal and learning goal are for the first stage?

This part of the formative assessment can be done in different ways. The most obvious way is to ask the students questions and show them which questions they should be able to answer at the end of the lesson series. Creating a rubric can also help. The rubric should be open-ended so that students are not limited by it and do not just concentrate on getting a passing grade based on the rubric.

- **Planning work**

- What is the time planning of performing each stage?
- Is it clear what should be done during the first stage and do the work meet the stage goal?
- Is it feasible to finish the stage on time?

The teacher can plan different moments in the process to gather information for this part of the formative assessment process. For instance, by providing different moments in the process when the students deliver a part of their work. In this phase, this could be an initial project plan made by the students. The teacher can also plan or hold informal discussions to gather knowledge on top of the more formal moments.

Based on the outcome of this assessment, the assessment should give an indication of how well the team understands the overall objectives of the project and how the first phase should be carried out. If it is not sufficiently clear to the team, it is recommended to redo the initiation phase. The waterfall method requires that the next phase is not started until the input is clear to the team. The assessment can be done by means of an interview with a questionnaire or a short project plan in which the above questions are answered.

### **Between phases**

At the end of each phase, an evaluation can be carried out on all four elements. The waterfall method makes it possible to re-evaluate the project so far and see how it should proceed. Therefore, all four elements of the formative evaluation can be carried out during a meeting with the team. During this meeting, the following should be discussed between the students and with the teacher. Based on the result of the evaluation, the teacher decides to proceed with the next phase.

- **Focus on product and learning goal**

- Are the project goals and connected learning goals still clear?
- Which learning goals are already met?
- Is in detail clear what the contribution of the project goal and learning goal are for the next stage?

The goals can be communicated again, and it is possible to check whether they are being achieved. Especially since the products delivered are not always the same. It is therefore



important that teachers communicate the objectives clearly again. So that students know what is expected of them and at what level they already meet the objective.

- **Planning work**

- Is the project still on track with regarding the time planning of performing future stages and the project as whole? If not, do we accept deviations on this plan?
- Is it clear what should be done during the next stage and do this work meet the stage goal?
- Is it feasible to finish the next stage on time?

Intermediate deliverables can be delivered as initially planned in the project plan. By following the plan, the teacher gains a better understanding of what has been done and what still needs to be done. It must be clear to the students that this assessment is not for a grade. This part of the formative assessment can also be carried out through more informal discussions with the team.

- **Providing feedback**

- Does the output contribute to the general project rubric?
- Is the output what can be expected by the team and by the teacher?
- Can we improve the quality of work in the next phase?

During this moment in the project, giving feedback has more the character of a formative evaluation of the performance of the agreed activities. Feedback can be given on the results delivered and other tasks mentioned in the project plan. It is important to note in this context that the feedback should be linked to the learning objectives. The feedback is aimed at improving the learning process the students follow in this project. This with the aim that the learning objectives are sufficiently achieved at the end of the project.

- **Reflection on execution**

- Is the whole team involved during execution of the project?
- Is the contribution from each member equal?
- Can the team improve the cooperation within the team, to contribute to the project as whole?

The teacher must provide the students with a structure so that they are able to reflect on the specific phase of the project. With the discussion provoked by the above questions, the students can improve themselves individually but also as a team the cooperation within this project. It is recommended that a person monitors the reflection process. This can be a teacher but also one of the students. The process guardian makes sure that during the reflection process a step-by-step plan that was agreed upon beforehand is followed. For example, forms can be provided that help the students to follow these steps of reflection.

### **After the last phase**

At the end of the last phase there is mostly a summative assessment on the work delivered but still a formative end assessment can be done on Reflection and Feedback on the project products by the customer / teacher. This can be done in an end of project meeting or by delivering a reflection report written by the students and teacher/customer.

- **Providing feedback**

- Does the output from the last stage contribute to the general project rubric?
- Is the learning goal of the last part of the project reached?
- Is the output from the last stage, what can be expected by the team and by the teacher?

The feedback given at the end of the project focuses on the whole project and on improving work in subsequent projects. The learning goals may not have been achieved in this project, but this feedback helps the students to achieve them in the next project.

- **Reflection on execution**

- Is the whole team involved during execution of the project?
- Is the contribution from each member equal?
- If we would do again this project what could be better?
- What are the risks recognized during execution of the project?

As with interim reflections, the teacher should provide structure for reflection. This time, the aim is to show the students what they can do better in the next project, so that they learn from their mistakes.

#### 5.3.4 Formative assessment during a Lean-Kanban project

As mentioned in 5.2.2, Lean with Kanban tool requires defining a complete task list at the beginning of the project. It is important that the team agrees that given the available time, the full task list can be executed during the project. During the project, it is checked periodically whether the workload can still be carried out in the given time. During execution, tasks can be added to or deleted from the task list as long as the planned time to complete all tasks does not exceed the available time (limit).

Also, during the implementation of this type of project, the four elements of formative assessment can help to control the process and ensure that the students will achieve their learning goals. The figure below shows at what points the assessments can take place.

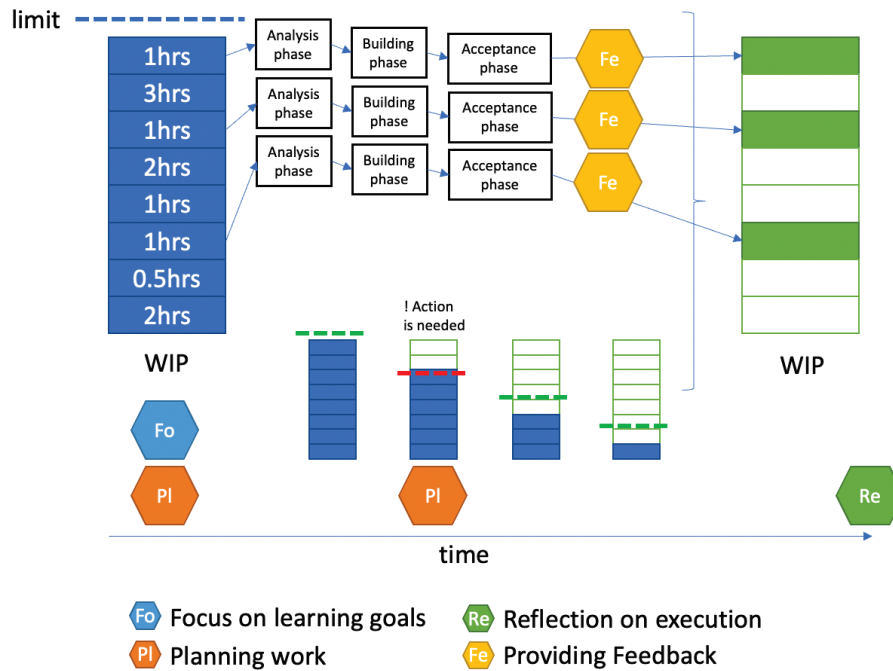


Figure 5-6 Formative assessment moments during a Lean-Kanban project.

### During setting up the WIP

The first important action is the creation of a "work in progress" (WIP) list. This action is important because otherwise the project may not start well and will have many deviations during implementation. Therefore, a formative evaluation can make an important contribution to the success factor of the project.

- **Focus on product and learning goal**

- Are the project goals and connected learning goals clear?
- Do the team have a good feeling about getting the WIP done? Are there enough sources and knowledge available for the team? If not, reconsider the task.
- Are all tasks contributing to the project goal and/or learning goals? If not reconsider the task.

The learning objectives should be included in the WIP list. Each task to be completed may have a learning objective. Also, a group of tasks may be linked to one or more learning objectives. When the learner starts a task, it should be clear to him/her what the learning objective for that task is. This information can be provided in different ways as already explained in the waterfall approach. Examples can be given, or a clear step-by-step plan can be made to complete the task in the right way.

- **Planning work**

- What is maximum time on which the students can spend on the project? This will be the start limit.
- Which tasks should be executed? How many efforts (in minutes) will it take to do the task? This list becomes the WIP ("work in progress"-list)
- Are the efforts of each task more or less equal? If not consider splitting tasks or combine tasks.

- Is the total tasks effort lower than the start limit? If not, reconsider the limit or the task list.

### **During execution of the project periodically (e.g., every week)**

Each period (e.g. weekly) a formative assessment is made which focuses on the planning of the work. During this time the team checks the WIP against the remaining time. If the total planned time of the tasks exceeds this limit, a discussion within the team should follow to solve this problem.

- **Planning work**

- What is the current limit (execution time left)?
- Does the total workload exceed the limit? If yes reconsider the WIP list to solve this problem.
- If tasks are removed, does it have impact on the learning goals? Is this acceptable? If not, consider changing the limit.

Depending on the number of remaining tasks, the teacher and the student can see if they are on track. In this situation, the students must plan by themselves, which teaches them skills in this area. The work done is also seen by the teacher because feedback is given when a task is finished. More about this in the feedback session. If tasks are removed from the WIP due to lack of time, it should be considered whether this has an impact on the achievement of the learning goals. Prioritisation can help in making the right choice.

### **When a task is finished**

When a task is finished by the team, the Lean Methods rule is to immediately sign off the work with the client/teacher to take it off the WIP list. This means that the teacher must give a formative indication of how well the work has been done and whether it meets the learning objectives. Alternatively, this assessment can be done by peer review within the team or by a peer team.

- **Providing feedback**

- Does the output contribute to the general project rubric?
- Is the learning goal defined for this task reached?
- Is the output what can be expected by the team and by the teacher?
- Can we improve the quality of work for next tasks?

The teacher can give feedback when the tasks are done. This should be linked to the learning goal assigned to the task. Feedback can also be based on which tasks were done first or which tasks remain to be done. This list is available, so that the teacher has information to give correct feedback.

### **At the end of the project**

At the end of the project, the students carry out a reflection on the project delivered. This can also be done earlier if necessary. The following questions may help:

- **Reflection on execution**

- Was the whole team involved during execution of the project?
- Was the contribution from each member equal?

- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tops and tips with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?

These questions can be used, for example, in an open discussion. This gives the students a structure for reflection. This helps them to look back and see what can be improved. Reflections can also be structured by providing a framework on paper to help the students gain a better understanding.

### 5.3.5 Formative assessment during an Agile-Scrum

Similar to Lean-Kanban projects, the process to be followed in Agile-Scrum projects is an iterative process. Instead of using a WIP, these projects use a so-called backlog for the project and in addition a sprint backlog for a part of the project. There is no limit to the time available. This type of project does have a sprint-time limit, but no limit regarding the entire project. The client/teacher decides if a project is considered done or if an additional sprint is needed. Only the execution of tasks within a sprint is very controlled and strictly agreed upon between the team members. This type of project also requires a (temporarily) assigned scrum master. A scrum master is responsible for facilitating the planning sessions during a sprint and aims to clear all obstacles that the team encounters during the execution.

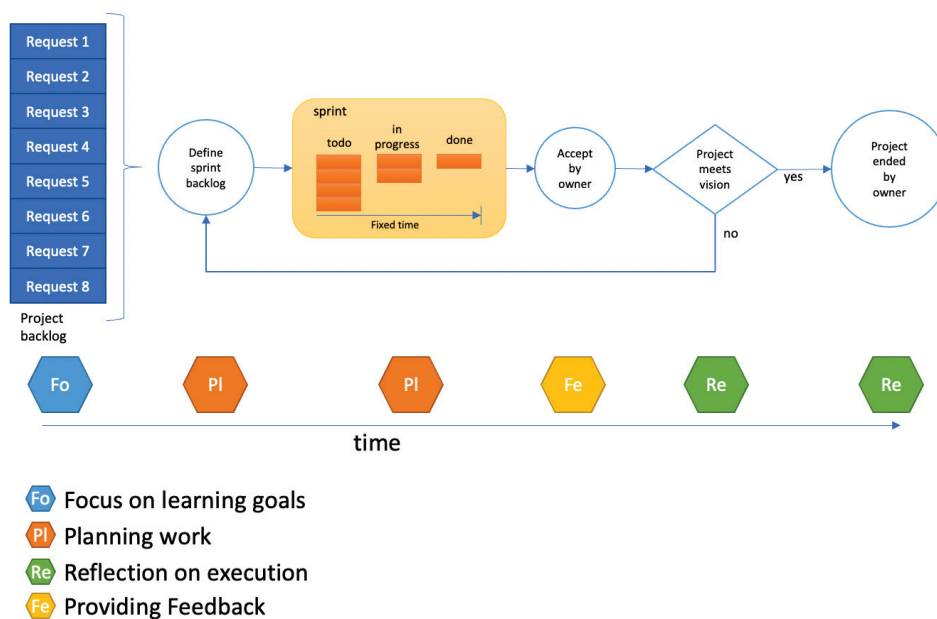


Figure 5-7: Formative assessment moments during an Agile-SCRUM project

#### During Initiation of the project

During the start-up of a project, a project backlog list is built up by the team. This list contains all the tasks that need to be carried out in order to fulfil the vision of the customer/teacher. There is no limit to this list (as in Lean-Kanban projects). During the project execution, the client/teacher are free to add or remove items from the list on request of the team. The list is owned and controlled by the client/teacher.

- **Focus on product and learning goal**

- Are the project goals and connected learning goals clear? Mostly this is mentioned in a so-called vision document provided by the customer/teacher.
- Do the team have a good feeling about getting the project backlog done? Are there enough resources and knowledge available for the team? If not, reconsider the task.
- Are all tasks contributing to the project goal and/or learning goals? If not reconsider the task.

The learning objective must be clear to the learners. The exact number and content of the sprints are not always fixed at the beginning. They can be changed during execution depending on whether the learning objectives are met. Thus, changes can still be made to the project if the focus should be on a learning objective that requires more or less attention.

### **At the beginning of a Sprint**

To start a sprint, the first action is to define a sprint backlog. This list contains all the tasks that will be done during the sprint period (usually 2 weeks). A formative assessment on the sprint plan can be done by the instructor after the sprint backlog is defined by the team.

- **Planning work**

- What is maximum time on which the students can spend on the project during this sprint?
- Which tasks should be executed? How many efforts (in minutes) will it take to do the task? This list becomes the sprint backlog.
- Are the efforts of each task more or less equal? If not consider splitting tasks or combine tasks.
- Is the total tasks effort lower than the limit of time the students can work on? If not, reconsider the sprint backlog list.

One possibility is to look at the scrum board to get information about the status of the work in the sprint. However, it is more difficult for the teacher to look further ahead than one sprint.

### **At the beginning of a lesson**

At the beginning of each lesson, the scrum master (a dedicated student from the team) evaluates the progress of the tasks in the sprint by discussing the tasks and their status with the team. After this meeting, the result can be formative evaluated.

- **Planning work**

- Is it still feasible to finish the sprint?
- Are there planning problems? Did the scrum master solve them correctly?
- If tasks are removed, does it have impact on the learning goals? Is this acceptable?

This advice is the same as during the start of a sprint. However, the expectation is that the team will have to go through fewer cycles to come to a proper planning. Also, information can be gathered in a more informal way by the teacher, such as simply starting a conversation with the team.

### **At the end of a sprint**

At the end of a sprint, the team must deliver the completed set of tasks to the customer/teacher. Based on the deliverables, a formative assessment can be made about the work. Teams have the opportunity to do a self-reflection on the performed sprint, this in order to make improvements regarding collaboration and achieving the learning goals in the next sprint.

- **Providing feedback**

- Does the output contribute to the general project rubric?
- Is the learning goal of the particular part of the project reached?
- Is the output what can be expected by the team and by the teacher?
- Can or should the team improve the quality of work for next sprints?

After each sprint, the work can be presented to the teacher. In this way, the teacher gathers information about the work performed by the students and where they currently stand with respect to the learning process. This information can also be collected in a structured way through peer feedback.

- **Reflection on execution**

- Was the whole team involved during execution of the project?
- Was the contribution from each member equal?
- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tops and tips with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?
- Did organize the scrum master the planning meetings correctly during the sprint?

It is an advised to have a reflection at the end of the sprint. This gives the opportunity to adjust future sprints and thus unmet learning goals can still be achieved at the end of the project. New sprints can be added that still focus on achieving the goal of the current project. It is also good if the reflection process is done in a structured way so that students can discover their learning points from the reflection exercise in the best possible way.

### **At the end of a project**

When the client/teacher decides that the final sprint meets the vision of the project, the project can be ended by holding a formative reflection meeting with the team.

- **Reflection on execution**

- Was the whole team involved during execution of the project?
- Was the contribution from each member equal during the project?
- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tops and tips with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?

As with the other two project management methods, a reflection on the entire process can be performed at this time. The results of this reflection on the process to meeting the learning objectives can then be taken to the next project.

#### 5.3.6 Feedback on research results

The guidelines described in this study were presented to the group of teachers who participated in the interviews at the beginning of the study. After the guidelines were presented, the following four questions were asked to them:

- **What do you think of the formative assessment guidelines presented? Do you have a top and a tip?**

All teachers indicated that the guidelines give a good overview of how to use formative assessments within the three project methods. Also, the breakdown of the three ways of carrying out projects is useful for shaping the lessons in practice.

Some teachers indicated that the questions in the guidelines are sometimes formulated in a closed way. For use in the classroom, it is advisable to change these to open and guiding questions.

- **Are there parts of these guidelines that have already been implemented or are partly in use in your organisation? In what way?**

Most teachers indicated that the waterfall method is often the underlying method that is used and often with an extension with a kanban-like task list, which is often called Scrum.

- **Do you see possibilities and usefulness in implementing (parts of) the formative assessment guidelines in your classroom? Please explain which parts and why or why not.**

All teachers indicated that the third method is difficult to apply within the lessons. These guidelines give a clear division of these methods, which is interesting to gain further practical experience with. The Lean-Kanban method probably comes across as natural to the students according to the teachers, which will probably make it easy to use.

- **Do you have any ideas how to further improve these guidelines?**

Three topics were suggested by the teachers. Firstly, translation of these guidelines into more practical tools such as: questionnaires, templates for students, offline tools and lesson plans is needed. Secondly, it was indicated that perhaps it should be investigated whether more emphasis on reflection and feedback during the execution of the tasks within the project would improve the learning curve. In the guidelines, these are mainly placed after the execution of the tasks. Thirdly, it was indicated that in a follow-up study, more ways of taking formative assessment could be investigated, such as peer review.

## 6 Conclusion and discussion

In secondary education, long-term projects are increasingly used as exercises to achieve deep learning goals within the existing curriculum. Within this research we have looked at how formative assessment can be applied during the implementation of such student projects. During this research, the current practice was first mapped by means of a qualitative interview method. Data has been collected on how formative assessment is currently applied during the implementation of long-term projects. Data was also collected on the use of methods to manage projects by students and teachers. In doing so, possible practical preferences of lecturers regarding the use of a certain project management method were also collected.



In summary, the first part of the study should answer the following sub-questions:

1. How are formative assessments currently done in schools?
2. What kind of project management methodologies are currently used?

The data collected from the interview with the teachers was used as input for a literature review to find answers to the following sub-questions:

3. For which part of the findings found in research question one and two can formative assessment be beneficial?
4. Which instruments in the project management methodology can contribute to improving formative assessment during student projects?

The literature review revealed that three important groups of project management methods play a role during project execution. An initial blueprint for a guideline design was made for these three common project management methods, encapsulating four formative assessments that had been suggested during the research. This answers the next and final sub-question:

5. What guidelines can be adopted by teachers who teach in long-term projects, based on the results of the interview conducted and the literature research, to improve formative assessment and thus contribute to deep learning?

In the next section we will answer the five sub-questions and finally the answer to the main research question:

- How can formative assessment be applied to long-term projects in secondary school education to contribute to the process of deep learning among students?

## 6.1 Findings

### *Practical observations*

As mentioned in the previous section, the first two sub-questions were answered by means of an interview study.

The research showed that there was no clear structural policy on the use of formative assessment during long-term projects. This does not mean that formative assessment was not used by the interviewees. During each interview, teachers indicated that some elements of formative assessment occurred in projects with the students. However, no corresponding correlation was found between the individual data of the interviewees. Also, (formative) reflection on the learning goals was mainly carried out at the beginning and at the end of the project. During the implementation of the project, little or no time was set aside for testing the learning objectives.

The degree of use of project management methods varied greatly among the interviewees. However, the conclusion was that a full implementation of a project management method did not occur and that elements from both the waterfall methods and the Agile-Scrum method were used. The waterfall method is mainly used for initial planning and for keeping track of activities for the purpose of a final report. The use of Scrum boards takes up a lot of teaching time and is sometimes used to distribute activities among team members at short notice. The teachers particularly mentioned planning problems with students. To deal with this, it was indicated that dividing large projects into smaller sub-projects often helped to maintain control over the project's progress in

relation to the project objectives. Many interviewees also indicated that they let the use of the method depend on the type of project, the type of group and the preference of the students.

### *Theoretical insights*

Research in the scientific literature shows that formative testing is suitable for use during the implementation of projects. It provides support on four focal points that play an important role during the implementation of long-term projects and the chance of successfully achieving the learning objectives. The four focal points for students are:

- Keep focus on project goals and learning goals.
- Perform reflection on the path taken to obtain the learning goals.
- Obtain feedback on activities performed during the project.
- Provide planning work during the execution of the project.

Literature research also shows that there are three main groups of project management methods, namely: Waterfall, Lean-Kanban and Agile Scrum. The latter two methods are iterative in mode of operation where the order of performing the activities is less important than in the waterfall method. In the waterfall method, the output of the previous phase is input for the next phase and can therefore not be called iterative. The research also provides indications as to which method can best be used in which situation. All three methods have advantages and disadvantages and are each suitable for a specific situation. Waterfall methods are the best choice when the path to achieving the project goals and learning objectives is clearly defined in advance. Agile-Scrum method is preferred when the path to achieving the project goals and learning objectives is unclear at the beginning.

Further analysis of the research data has also shown that all three methods can be implemented in a classroom environment. Although each project management method deals differently with the four focal points described above, the focal points are supported by all three methods. The analysis provides a translation of the methods into a classroom environment that served as input for specific recommendations. In paragraph 5.3, these recommendations are described as a working method for each project management method.

## 6.2 Contributions of the study

By combining practical experiences of formative assessment and managing student projects with elements from a theoretical approach, the research has shown that formative assessment in long-term student projects can make an important contribution to the achievement of learning goals. From this research a recommendation has emerged on how long-term projects can be organized according to three different project management methods and how four points of interest can be formatively assessed in each method.

The practical contribution is a guideline how student projects can be classified into one of the three approaches and how and when the formative assessments can be made during such a project. The three types of approaches (Waterfall, Lean-Kanban, and Agile-Scrum) differs in how formative assessments can be implemented in the classroom. The practical guideline gives a direction how formative assessments can be implemented in each project. By embedding formative assessment in a student project in this way, it is expected that students will follow the path to achieving their learning goals more easily and in a more controllable way while carrying out the projects.

This guideline with recommendations mentioned in paragraph 5.3, which has emerged from data collected in practice and scientific literature research, ultimately provides the answer to the research question: "How can formative assessments, taken during long term projects at secondary school

HAVO/VWO, improve and contribute better to deep learning goals?”. Although a practical test of these recommendations goes beyond the boundaries of this research, it is expected that by implementing these guidelines, a contribution will be made to creating deep learning effects among students. The teachers who reviewed the guidelines were all positive, but also indicated that the guidelines need to be further developed into useful tools for use in the classroom. Because the basis of these guidelines is partly based on practical experiences that have emerged from the research itself, but also because used scientific research has already been tested in practice, it is expected that a translation of the guidelines into a practical tool for the teacher and the student will be possible.

### 6.3 Limitation of the study

It is important to note that this study was limited in the processing of practical data. During the first phase of the research, an interview was conducted with a very limited population of teachers in the Netherlands (6). In a possible follow-up research, it is recommended to work with a larger group of teachers, so that the qualitative data becomes more representative.

Also, the interview was conducted without a direct link to a specific student project. In order to get a more accurate picture of how formative assessment can be an added value during student projects, it is advisable in a follow-up study to follow similar projects and to be able to obtain more detailed data during implementation. With this more detailed data it should be possible to confirm the four focus areas for formative assessment found in this study from the practical perspective.

Finally, there is the limitation of the type of educational subjects covered in this study. The study focused on O&O classes and computer science classes, but the results of the study should be checked in future research on a wider range of educational subjects.

### 6.4 Future research

Additional research is needed to confirm whether the practical guideline can be applied in practice. Such research should also be able to provide information on whether the contribution of these formative assessments as proposed in the guideline leads to better and/or faster achievement of the learning goals by the students. By measuring projects during implementation, it is possible to obtain more data to confirm the benefits of formative assessment in project education.

It is recommended that the guidelines first be converted into practical tools (such as templates for students) that can be used in the classroom, before applying them in a practical test with students.

## Bibliography

Bakar, M. A., Jailani, N., Shukur, Z., & Yatim, N. F. M. (2011). Final year supervision management system as a tool for monitoring Computer Science projects. *Procedia-Social and Behavioral Sciences*, 18, p273-281.

Belwalkar, B. B., Heagney, J. (2019). *Fundamentals of project management*. New York: American Management Association

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: principles, policy & practice*, 5(1), p7-74.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability (formerly: Journal of Personnel Evaluation in Education)*, 21(1), p5.

Bok, H. G., Teunissen, P. W., Favier, R. P., Rietbroek, N. J., Theyse, L. F., Brommer, H., Jaarsma, D. A. (2013). Programmatic assessment of competency-based workplace learning: when theory meets practice. *BMC medical education*, 13(1), p1-9.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), p77-101.

Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century US workforce*. Washington DC : Partnership for 21st Century Skills.

Crawford, L., Cooke-Davies, T., Hobbs, B., Labuschagne, L., Remington, K., & Chen, P. (2008). Governance and Support in the Sponsoring of Projects and Programs. *Project Management Journal*, 39(1\_suppl), S43–S55. <https://doi.org/10.1002/pmj.20059>

Crone, E. (2018). *Het puberende brein: Over de ontwikkeling van de hersenen in de unieke periode van de adolescentie*. Amsterdam: Prometheus.

Czerkawski, B. C. (2014). Designing Deeper Learning Experiences for Online Instruction. *Journal of Interactive Online Learning*, 13(2), p29-40.

Gulikers, J. T. M., Baartman, L. (2017). *Doelgericht professionaliseren. Formatief toetsen met effect! Wat DOET de docent in de klas? Eindrapport NRO-PPO overzichtsstudie dossiernummer 405-15-722*. Den Haag: NRO.

Hattie, J., Timperley, H. (2007). The power of feedback. *Review of educational research*, 77(1), p81-112.

Heagney, J. (2016). *Fundamentals of project management. 5<sup>th</sup> edition*, New York: Amacom.

Hersey, P., Blanchard, K. H. (1997). Situational leadership. *Dean's Forum*, 12(2), p5.

Hrablik Chovanova H., Husovic R., ea. (2020). *Agile Project Management – What is it?*. Bratislava: Slovak University of Technology.

Jolles, J. (2007). Neurocognitieve ontwikkeling en adolescentie: enkele implicaties voor het onderwijs. *OnderwijsInnovatie*, maart 2007, p30-32.

Kaiser, J., Möller, J., Helm, F., & Kunter, M. (2015). Das Schülerinventar: Welche Schülermerkmale die Leistungsurteile von Lehrkräften beeinflussen. *Zeitschrift für Erziehungswissenschaft*, 18(2), p279–302.

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of advanced nursing*, 72(12), p2954-2965.

Leahy, S., Lyon, C., Thompson, M., & Wiliam, D. (2005). Classroom assessment: Minute by minute, day by day. *Educational Leadership*, 63(3), p18–24.

Manifesto, A. (2001). *Agile Manifesto for Software Development*. Retrieved from: <https://www.agilealliance.org/agile101/the-agile-manifesto/>

Meredith, J., Mantel jr., S. (1989). *Project Management - A Managerial Approach. 2nd edition.*, Cincinnati, Ohio: John Wiley & Sons.

Mergendoller, J. R., Markham, T., Ravitz, J., & Larmer, J. (2006). *Pervasive Management of Project Based Learning: Teachers as Guides and Facilitators*. United States: Buck Institute for Education.

Mkoba E., Marnewick C., (2017). Conceptual framework for auditing agile projects. University of Johannesburg, *IEEE Access* 2020.3007874

Office of Government Commerce & Great Britain, (2002). *Managing Successful Projects with PRINCE2*. Norwich: Stationery Office.

Parker, W. C. (2018). Projects as the spine of the course: Design for deeper learning. *Social Education*, 82(1), p45-48.

Pellegrino, J. W., Hilton, M. L. (2013). *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century*. Washington, DC.: The National Academies press.

Ramaprasad, A. (1983). On the definition of feedback. *Behavioral Science*, 28(1), p4-13.

Sadler, R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, 18, p119–144.

Schunk, D. H. (1996). Goal and Self-Evaluative Influences During Children's Cognitive Skill Learning. *American Educational Research Journal*, 33(2), p359–382. <https://doi.org/10.3102/00028312033002359>

Schwaber, K. (1997). Scrum development process. In *Business object design and implementation*, p117-134. London: Springer

Silfhout, G. van, Trimbos, B. & Hasselerharm, S. (2018). *Formatief evalueren: het belang van de dialoog over leerdoelen en succescriteria*. Enschede: SLO.

Stacey, R (2002), *Strategic management and organisational dynamics: The challenge of complexity (3rd ed.)*. Harlow England: Prentice Hall.

Stewart, T. A. (1998). *Intellectual Capital: The new wealth of organisation*. New York: Currency/Doubleday.

Sutherland, J., (2014), *Scrum: The Art of Doing Twice the Work in Half the Time*, London: Random House Business

Svejdarova S., (2019), Power of feedback – Agile Project learning. *Edulearn19*, p3904-3910.

Thomas, S., Busby, S. (2003), Do industry collaborative projects enhance students' learning?. *Education + Training*, Vol. 45(4), p226-235, <https://doi.org/10.1108/00400910310478157>

Trilling, B., Fadel, C. (2009). *21st century skills: Learning for life in our times*. New York: John Wiley & Sons.

Wells, H. (2012). How effective are project management methodologies? An explorative evaluation of their benefits in practice. *Project management journal*, 43(6), p43-58.

Wiliam, D., Thompson, M. (2008). *Integrating assessment with learning: "What will it take to make it work?"*. In *The Future of Assessment*, p50-80, New York: Routledge.

White, D., Fortune, J. (2002). Current practice in project management—An empirical study. *International journal of project management*, 20(1), p1-11.

## Appendix 1: Questionnaire storybook used during the interviews

### Purpose

The purpose of this questionnaire is to gain data for our research during phase 1. The data which will be collection should give the researchers a good insight about using formative testing during long term student projects.

### Setting of the interview

The interview will be given during a single meeting with the respondent. The interview will use the storybook provided in this document to obtain qualitative data in a structured way. During the meeting the interview will take place in an open discussion. It is not needed to follow the questions one by one, as long all subjects have been discussed during the meeting. The researchers will also ask deepening or clarifying questions. Often called a semi-structured interview. The interview will take approximately one hour.

Before the start of the interview the purpose of the interview will be made clear to the interviewee by provide a short introduction of our research and the meaning of the research.

The group of interviewees will be 1<sup>st</sup> grade teachers of the classes Computer Science and O&O. The population of the data collection will be between 5 - 10 persons from different schools.

### Storybook

#### Introduction

During this part of the interview some relevant data will be recorded with regarding the responsibility of the interviewee.

Which course are you teaching?

Which years are you teaching?

How long are you teaching?

Do you think there are other things that might be relevant to know for us?  
You can always tell it at the end or in-between as well.

#### Define the generic process structure of executing a student project.

This part of the interview should give an overview of the process how a student project is being executed. The interviewee is being asked to define the steps of the whole process. In the next part of the interview each step in the process will be discussed in detail. During this part a sketch will be drawn from the process and used as discussion paper for the next part of the interview.

Describe the project process you use now for reaching learning goals with students in steps. From the start until the end of the project.

- How do you start-up a project?
- Are there steps with deadlines / milestones?
- How do you end a project?

Which steps are contributing to the aim of reaching the learning goals?

Which steps are important to measure the status of reaching learning goals?

### Define the usage of formative evaluation during the project

In this research we define formative evaluation (testing) as follows:

*“It is to be interpreted as encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged.”*

The following questions are about the usage of these kind of evaluations during the project. For each project step we defined in the previous section we would like to go into details.

Can you tell me what you know about formative evaluation in general?

Can you talk me through the formative evaluations you are using within the process you just described?

### Determine the completeness of the formative evaluation during the process.

In this research we determine five phases in a complete formative evaluation cycle. Therefore, we would like to go through each mentioned formative evaluation cycle in the previous section. It is our aim to recognise which phases are (partly) part of the current evaluation process and which are not.

The phases we determined are:

1. Clarifying expectations
2. Generating and collecting student data
3. Analyse and interpret reactions
4. Communicating with students about results
5. Take follow up action

Do you recognise the five phases of formative evaluation compared with what you do?

#### **Phase 1 clarifying expectations**

Do you formulate learning goals and or success criteria?



- If yes, are you sharing the success criteria with the students?
- If not, why not what is your reason not to share?

Is there a difference in learning goals and project goals?

- If yes, how do you share this with the students?

How do you communicate these learning goals with the students?

Do you include students in this evaluation process?

Are the learning goals specific or somewhat open?

### **Phase 2 generating and collecting student data**

Which data are you collecting?

What kind of methods do you use to collect data?

Are the methods of collecting data connected to the learning goals?

### **Phase 3 analyse and interpret reactions**

How to you analyse data or understanding of students?

Where is your focus when analysing the results?

What tools do you use to analyse the results?

What are de expectations of the outcome of the data? What do you want to prove or measure?

### **Phase 4 communicating with students about results**

What is your process of giving feedback?

What kind of feedback do you give?

Do you give structure for peer and self-assessment? For improving themselves

### **Phase 5 take follow up action**

How do you improve the evaluation for next time?

Questions about project management

In this part of the interview, we are going deeper in the usage of project management tools / methods during the student projects. The aim is to obtain if certain (parts of) methods are being used and how are they implemented in the process.

Are you using a known project management method, during the execution of the project? If so, which one, and why this one? If so, which elements of this method are being used.
Do you spend time to implement these elements in the projects?
Is using these elements a defined part of the learning goals, or more some help for students to keep the project under control by themselves?
Do you measure the understanding of these elements by the student?
Can you talk me through how you use it?
Do you use these elements in the formative evaluation process?

### Closing questions

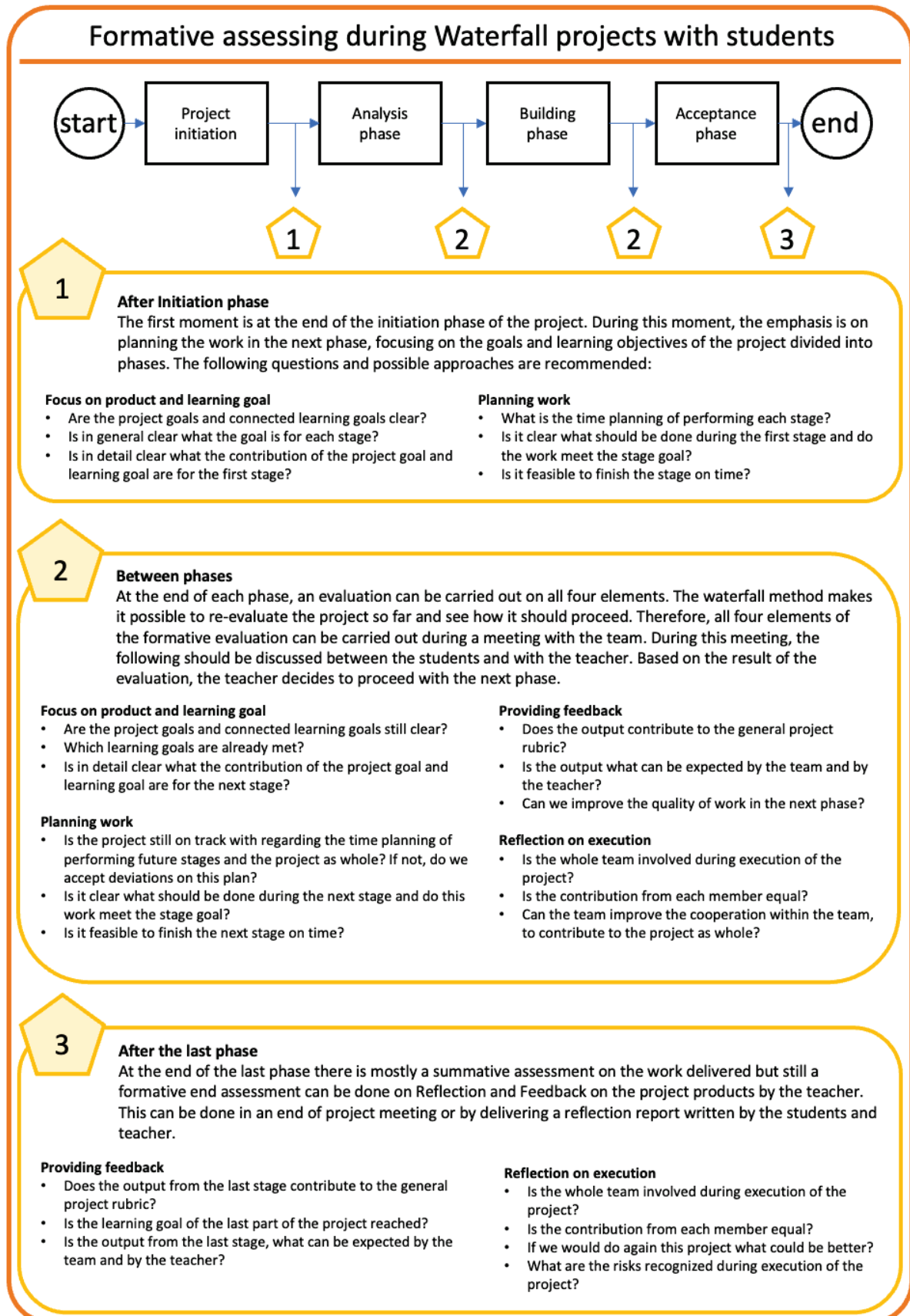
This is the end of the interview. On the table should be a clear sketch of the process with filled in the moments of formative evaluations as well the usages of elements from a project management method.

Is the sketch a good and complete understanding of the execution of student projects in your class?
Is there something you want to say we missed in this interview or think is important?

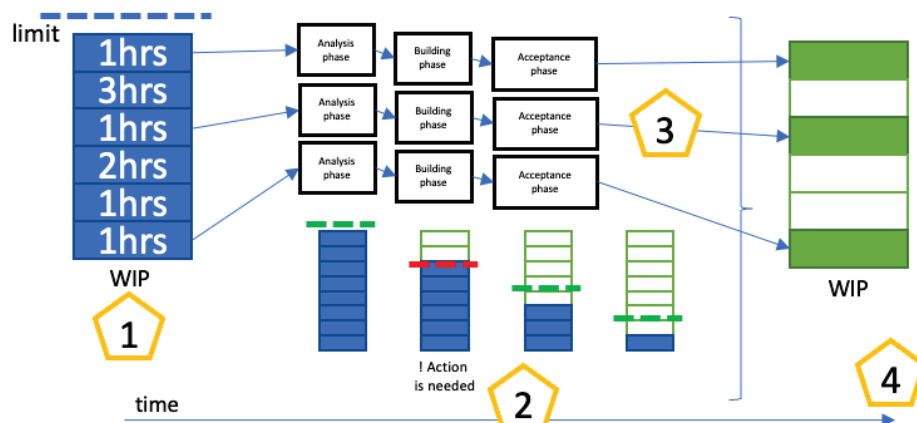
## Appendix 2: Qualitative data obtained from the interviews (selection)

T - Leerdoelen	T- conclusie tijdens uitvoer les formatief	K -Reflecteren	T- Peer feedback	K -verbeteren van het proces als docent	K - SCRUM vs	K -hoeveelheid werk	T -conclusie 1 projectverschil ob en
<p>Leerdoelen op het scrum bord</p> <p>Leerdoelen verduidelijken in project boekje met terugkoppeling</p> <p>leerdoelen zijn bij ons voornamelijk gericht op het proces.</p> <p>samenwerken, organisatorische kant, begrijpen van hoe je een applicatie in bepaalde structuren bouwt. Wij zien die vooral geïntegreerd en niet als losse onderdelen</p> <p>we formuleren van tevoren niet de leerdoelen. wel verschillende leerlijnen die lopen eerder buiten de opdracht om.</p> <p>verschillende leerdoelen, natuurlijk. De leerlingen stellen wel hun eigen leerdoel op</p> <p>(technische) leerdoelen of vaardigheden -ook-</p> <p>leerdoelen zitten in het project verwerkt</p> <p>geen specifieke leerdoen maar zelf kiezen uit 2 competenties</p> <p>Leerlingen zeggen zelf waar ze aan werken en die doelen staan los van het project</p> <p>+ Een kaart toevoegen</p>	<p>Coaching gesprekken</p> <p>Pitstop gesprekjes</p> <p>feedback op tijdens een gesprek en op basis daarvan stellen ze een nieuw leerdoel</p> <p>dingen die we doen al een soort van formatief evalueren kunnen noemen: gewoon de dagelijkse gang van zaken bij o&amp;o.</p> <p>Terwijl ze aan het schrijven zijn en dan overleggen zijn, sluit ik zoal dat mooi heet "incidenteel" aan bij een overleg. In absolute zin. weet dat ik iedere 2-3 weken iedereen in een projectgroep je even minimaal één keer gesproken hebt.</p> <p>Tussendoor dus mondeling en ik maak wat algemene aantekeningen, zeg maar. En op het einde van het project, dan moeten zij echt schriftelijk een groot reflectieverslag schrijven.</p> <p>Ik daag wel uit, ja, dat probeer ik zeker te doen van nou fijn dat je tot hier gekomen bent. We hebben nog zoveel weken. Ik verwacht wel dat je een aantal zaken meer nog doet en dat zie ik dan ook wel gebeuren.</p> <p>Bezig ophang plaats is plek om vragen te stellen</p> <p>Kijken waar groepjes mee bezig zijn op het scrum bord</p> <p>Scrum geeft een overzicht waar ze mee bezig zijn</p> <p>+ Een kaart toevoegen</p>	<p>Leerlingen ook zelf inzicht in de rubric door zelf in te vullen</p> <p>Competentie monitor</p> <p>Groeidocument om groei van leerling zelf bij te houden</p> <p>Bewijslast om groei per competentie te laten zien</p> <p>Na elk project 8 competenties waar je met de leerlingen bij stil staat</p> <p>Presentation of learning Pol met doorlopende leerlijn</p> <p>In de bovenbouw zeggen we, oké, ik wil dat je minimaal 800 woorden schrijft over wat er dit project is gebeurd. Dit zijn een aantal dingen waaraan je kan denken. niet een invuloefening</p> <p>leerlingen laten reflecteren aan het begin en einde</p> <p>bovenbouw noemen we dit een pop -persoonlijk ontwikkel plan-. Werk echt fantastisch, maar niet heus.</p> <p>Wanneer evalueren: begin einde vooral en als merkt dat meer nodig is</p> <p>Daar zit complexiteit met van waar zit het leervermogen voor een leerling en dat beperkt je dan als je het gaat kaderen meer voor jezelf dan dat ie het</p> <p>+ Een kaart toevoegen</p>	<p>Peer feedback op het proces</p> <p>Peer feedback 11 punten verdelen</p> <p>De formatieve rubric reflecteren ze zelf en bespreken het eerst met elkaar voordat de docent erbij komt.</p> <p>Na elk project vullen ze een reflectieformulier in. competentie monitor.</p> <p>ontwikkeldoelen In de onderbouw is het reflectieverslag echt om hoe verschillende competenties samenwerken en individueel werken.</p> <p>peer feedback</p> <p>+ Een kaart toevoegen</p>	<p>Niet veel veranderingen in het formative evaluatie proces</p> <p>eigenlijk alleen maar vanuit management om het naderhand te kunnen beoordelen en van dat je ze anders wil kaderen om het te om het voor je voor jezelf te kunnen toetsen.</p> <p>Verbeteringen worden meegenomen in het proces</p> <p>Tijdsdruk in formatief evalueren</p> <p>Flexibiliteit in het proces</p> <p>verbeteringen in het proces</p> <p>Wanneer de focus op proces voor de leerlingen en wanneer feedback</p> <p>+ Een kaart toevoegen</p>	<p>in onderdeel gebruiken we geen specifieke tools voor en we benoemde het ook niet als een project</p> <p>In de methode van informatica actief zit er een mooi voorbeeldje in va dit is een project volgens waterval en dit is een project volgens scrum. En dat Laten we In het begin even lezen.</p> <p>Er zijn allerlei hippe tools voor scrummen. En heb ik geprobeerd, en ja, dat was meer effect dan dat het opleverde tenminste hoe wij het inzetten</p> <p>Ligt een klein beetje aan de hoeveelheid beweging van een leerling en of leerlingen heel graag op korte termijn dingen wil hebben. Die zou eerder naar scrum toegripen, omdat daar een aantal van die rollen in zitten en een daily standup, enz.. Ik zie dat de leerling die iets theoretisch zijn aangelegd, meer plezier halen uit de waterval methode.</p> <p>Geen project management tools</p> <p>echt gescrumd is met een scrum master bij. Ik heb dat niet gedaan. Ik heb wel eens iets in de brugklas geprobeerd met een soort van scrum light Als het ware te gebruiken. Ze namen een a3 te en daar staat gewoon wat post-it's met hun taken. Alle taken die nog gedaan moet worden of waar ze mee bezig zijn en gedaan zijn in 3 kolommen en dan met post-its van de ene kant naar de andere kant.</p> <p>ga eens kijken naar die management tools. Welke zijn beschikbaar? kies er eentje die bij je past en dan gaan uitproberen in je project. Dus draai ik het</p> <p>+ Een kaart toevoegen</p>	<p>ik zeg altijd van inzicht, krijg overzicht hebben van overzicht</p> <p>Een tussenstand en moesten presenteren. Ja, dat heeft wel geholpen.</p> <p>Ja, dat zeg maar verlangen naar de zee en je bouwt een boot. Als je dat niet over de Bühne krijgt, dan is het gewoon stampen voor die leerlingen om er doorheen te komen hè.</p> <p>Dat vind ik dan bij het projectonderwijs heb je wel meer de mogelijkheid waarbij iedereen op zijn eigen tempo dat kan doen. Ja, wat ze eigenlijk kunnen doen, hè? Waar hoeverre een ontwikkel potentie, zeg maar wordt aangesproken.</p> <p>een Plan van aanpak gaan schrijven</p> <p>in plaats van de standaard 4. 3 projecten, omdat we dan iets meer tijd hebben....leerlingen vaak tijd te kort hebben of ervaren dat ze tijd te kort hebben.</p> <p>dan staat er in de opdracht dat je 3 ideeën moet hebben en dan gaan ze nog 2 ideeën bij bedenken die ze sowieso niet gaan doen.</p> <p>formatief toetsen we haalbaarheid. Ze hebben erg moeite mee om in te schatten hoeveel tijd een activiteit kost</p> <p>We hebben een rubric met daarin waarin de producten minimaal aan moeten voldoen. Waar wordt aangeven of dit is haalbaar? Is dit schaalbaar? Heeft iedereen iets te doen?</p> <p>een groeps logboek en drie maten ze dan de</p> <p>+ Een kaart toevoegen</p>	<p>Projectplan in de onderbouw vs bovenbouw</p> <p>de laatste fase van de examenklas doen we wel een project. klein beetje afhankelijk van de project methodiek.mogelijkheid iets te scrummen of iets met waterval,</p> <p>De aanpak -in onderbouw- is, zeg maar je je opdrachtenboekje, die ze dan schrijven en daarna gaan ze ermee aan de slag, gaan ze de opdracht uitvoeren en hebben ze een eind deadline nog.</p> <p>meer vrije invulling in de bovenbouw</p> <p>Go, No go moment in bovenbouw</p> <p>Bovenbouw krijgen ze technieken aangeleerd voor hun zelf te kiezen</p> <p>In de bovenbouw zie je wel eens dat leerlingen zelf deadlines afspreken met de opdrachtgever,</p> <p>+ Een kaart toevoegen</p>

## Appendix 3: Infographic guidelines



## Formative assessing during Lean-Kanban projects with students



1

### During setting up the WIP

The first important action is the creation of a "work in progress" (WIP) list. This action is important because otherwise the project may not start well and will have many deviations during implementation. Therefore, a formative evaluation can make an important contribution to the success factor of the project.

#### Focus on product and learning goal

- Are the project goals and connected learning goals clear?
- Do the team have a good feeling about getting the WIP done?
- Are there enough sources and knowledge available for the team? If not, reconsider the task.
- Are all tasks contributing to the project goal and/or learning goals? If not reconsider the task.

#### Planning work

- What is maximum time on which the students can spend on the project? This will be the start limit.
- Which tasks should be executed? How many efforts (in minutes) will it take to do the task? This list becomes the WIP ("work in progress"-list)
- Are the efforts of each task more or less equal? If not consider splitting tasks or combine tasks.
- Is the total tasks effort lower than the start limit? If not, reconsider the limit or the task list.

2

### During execution of the project periodically (e.g., every week)

Each period (e.g. weekly) a formative assessment is made which focuses on the planning of the work. During this time the team checks the WIP against the remaining time. If the total planned time of the tasks exceeds this limit, a discussion within the team should follow to solve this problem.

#### Planning work

- What is the current limit (execution time left)?
- Does the total workload exceed the limit? If yes reconsider the WIP list to solve this problem.
- If tasks are removed, does it have impact on the learning goals? Is this acceptable? If not, consider changing the limit.

3

### When a task is finished

When a task is finished by the team, the Lean Methods rule is to immediately sign off the work with the client/teacher to take it off the WIP list. This means that the teacher must give a formative indication of how well the work has been done and whether it meets the learning objectives. Alternatively, this assessment can be done by peer review within the team or by a peer team.

#### Providing feedback

- Does the output contribute to the general project rubric?
- Is the learning goal defined for this task reached?
- Is the output what can be expected by the team and by the teacher?
- Can we improve the quality of work for next tasks?

4

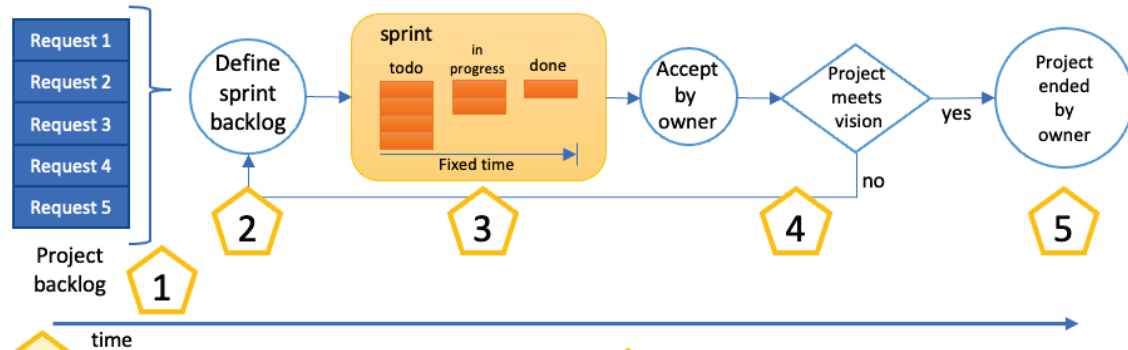
### At the end of the project

At the end of the project, the students carry out a reflection on the project delivered. This can also be done earlier if necessary. The following questions may help:

#### Reflection on execution

- Was the whole team involved during execution of the project?
- Was the contribution from each member equal?
- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tips and tricks with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?

## Formative assessing during Agile-Scrum projects with students



1

### During Initiation of the project

During the start-up of a project, a project backlog list is built up by the team. This list contains all the tasks that need to be carried out in order to fulfil the vision of the teacher. There is no limit to this list. During the project execution, the teacher is free to add or remove items from the list on request of the team. The list is owned and controlled by the teacher.

#### Focus on product and learning goal

- Are the project goals and connected learning goals clear?
- Do the team have a good feeling about getting the project backlog done? Are there enough resources and knowledge available for the team? If not, reconsider the task.
- Are all tasks contributing to the project goal and/or learning goals? If not reconsider the task.

2

### At the beginning of a Sprint

To start a sprint, the first action is to define a sprint backlog. This list contains all the tasks that will be done during the sprint period (usually 2 weeks). A formative assessment on the sprint plan can be done by the instructor after the sprint backlog is defined by the team.

#### Planning work

- What is maximum time on which the students can spend on the project during this sprint?
- Which tasks should be executed? How many efforts (in minutes) will it take to do the task?
- Are the efforts of each task more or less equal? If not consider splitting tasks or combine tasks.
- Is the total tasks effort lower than the limit of time the students can work on? If not, reconsider the sprint backlog list.

3

### At the beginning of a lesson

At the beginning of each lesson, the scrum master (a dedicated student from the team) evaluates the progress of the tasks in the sprint by discussing the tasks and their status with the team. After this meeting, the result can be formative evaluated.

#### Planning work

- Is it still feasible to finish the sprint?
- Are there planning problems? Did the scrum master solve them correctly?
- If tasks are removed, does it have impact on the learning goals? Is this acceptable?

4

### At the end of a sprint

At the end of a sprint, the team must deliver the completed set of tasks. Based on the deliverables, a formative assessment can be made about the work. Teams have the opportunity to do a self-reflection on the performed sprint, this in order to make improvements regarding collaboration and achieving the learning goals in the next sprint.

#### Providing feedback

- Does the output contribute to the general project rubric?
- Is the learning goal of the particular part of the project reached?
- Is the output what can be expected by the team and by the teacher?
- Can or should the team improve the quality of work for next sprints?

5

### At the end of a project

When the client/teacher decides that the final sprint meets the vision of the project, the project can be ended by holding a formative reflection meeting with the team.

#### Reflection on execution

- Was the team involved during execution of the project?
- Was the contribution from each member equal during the project?
- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tips and tricks with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?

#### Reflection on execution

- Was the whole team involved during execution of the project?
- Was the contribution from each member equal?
- Can the team improve the cooperation within the team, to contribute to the project as whole?
- Are there tips and tricks with regarding the planning at the beginning and during the execution of the project?
- Does everybody meet the learning goals? If not, what did you miss during the project?
- Did organize the scrum master the planning meetings correctly during the sprint?

## Appendix 4: evaluation form

What do you think of the formative assessment guidelines presented? Do you have a top and a tip?

Are there parts of these guidelines that have already been implemented or are partly in use in your organisation? In what way?

Do you see possibilities and usefulness in implementing (parts of) the formative assessment guidelines in your classroom? Please explain which parts and why or why not.

Do you have any ideas how to further improve these guidelines?