Cracking the code

Investigating feedback perceptions in large Computer Science Education classes

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Investigating feedback perceptions in large Computer Science Education classes

Ljubov van Beek

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Dissertation

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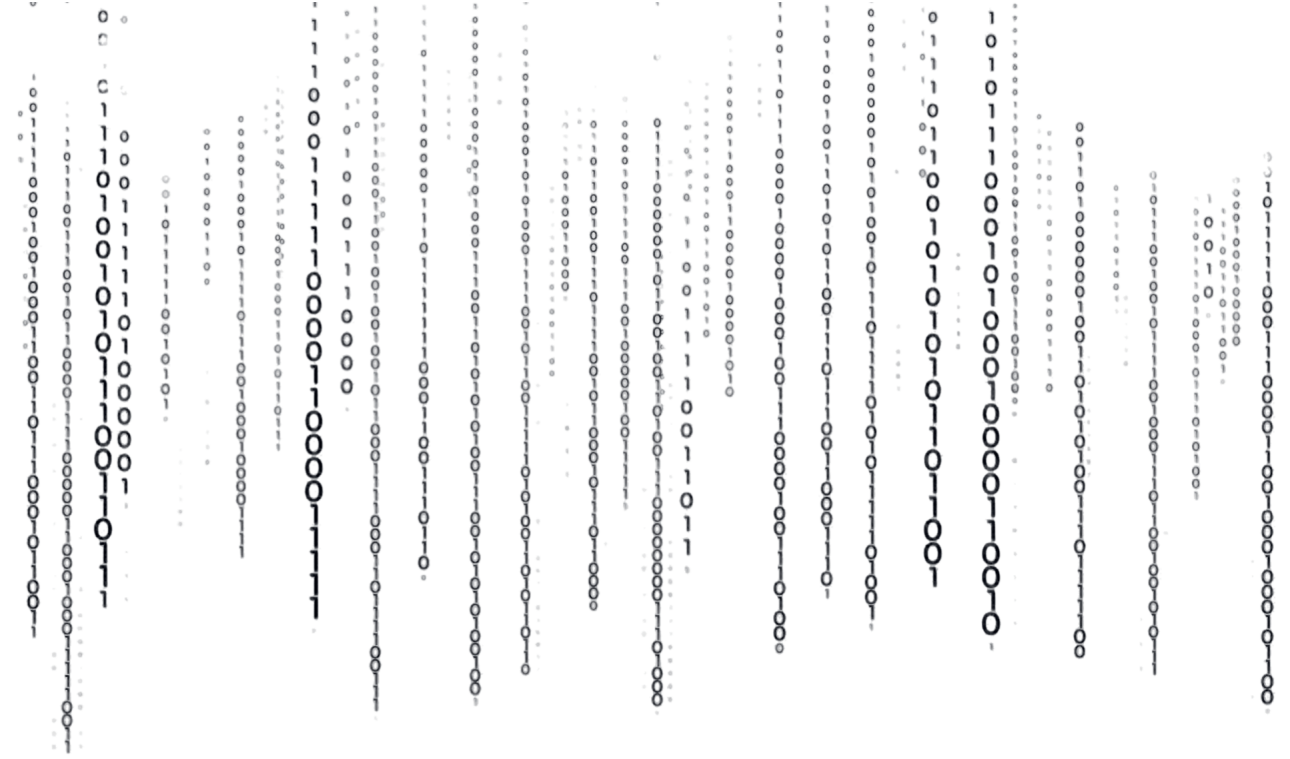


CRACKING THE CODE:

Investigating feedback perceptions in large Computer Science Education classes

Table of Contents

Summary

Promoting students' effective engagement with instructional feedback is a well-known issue amongst instructors, educators and scholars investigating students' effective uptake of instructional feedback. Students do not always use instructional feedback that they receive, in reality – students often ignore it or do not use it effectively to improve learning. Previous research was focused on instructors playing the key role in this process; therefore, many current recommendation, advices and guidelines are structured around design of the feedback message itself. Recent research, on the contrary, acknowledges the role of a student and student's individual agency in the process of instructional feedback application: every student decides whether or not to engage with instructional feedback and whether or not to apply it consequently.

While acknowledging student's individual agency in willingness to engage with instructional feedback provides a fresh perspective on the process of feedback application, it also poses many challenges for instructors and scholars in the field. Students develop individual attitudes towards instructional feedback based on, for example, previous experience, relationships with the feedback provider or even various aspects of learning environment. Such attitudes are called Feedback perceptions. Feedback perceptions impact how students perceive feedback that is provided to them, and, therefore, students' motivation to interact with feedback and apply it to improve learning. It is important to mention, however, that positive feedback perceptions do not always result in students' engaging with instructional feedback. The entire process of feedback application starts with the students' appropriate mindset to be able to receive instructional feedback, students' motivation to accept feedback, make sense of feedback, then move towards drawing a plan to apply received feedback and finally utilize effective learning strategy to improve learning. During every step of this process students might face challenges that disrupt the effective feedback application process: with every step-in feedback process, a whole new variety of problems arise that impact the consequent steps. However, with the new concept of Feedback perceptions

emerging in the studies, instructors and scholars have an opportunity to investigate and understand the process behind instructional feedback application better.

To contribute to the field's understanding of feedback perceptions in students' learning, and to support efforts seeking to promote effective uptake of instructional feedback, this thesis sought to investigate what – the phenomenon of feedback perceptions, and how – the influence of feedback perceptions on both instructors' teaching and students' learning. To meet our research goal, we studied students' feedback perceptions, students' motivation and students' use of learning strategies, and relied on close collaboration with a community of involved – instructors of Computer Science.

For our initial study we explored feedback perceptions amongst first-year bachelor students of Computer Science in the context of a large class (Chapter 2). Aspects of the learning environment, such as, for example, previous experience with feedback, the discipline itself and the relationships with instructors are some of the aspects that are known to influence students' perceptions of instructional feedback, therefore we were interested in gaining insights on how students perceive instructional feedback in a complex learning environment and what aspects of this learning environment student report to be important in conjunction with their feedback perceptions. We elicited the ideas, experiences and opinions of the seventeen students through semi-structured group interviews. Data analysis showed that the students perceived instructional feedback as useful and valuable, however, students do not use received feedback to improve learning. The study revealed several essential aspects that students reported as influential in terms of perceiving and applying instructional feedback. Such aspects included, for example, the characteristics of the feedback provider, learning environment and the feedback message itself. The study concluded that despite positive feedback perceptions, students have a wide variety of reasons to not engage with instructional feedback. Furthermore, this study demonstrated a large variety of students' feedback perceptions and students' reasons to ignore instructional feedback.

In the second study (Chapter 3), we sought to investigate the relationships between certain feedback perceptions that students demonstrate, and a large range of students' aspects of

motivation and a variety of students' learning strategies used consequently. Given the large variety of feedback perceptions that students report, we were interested in investigating how those feedback perceptions influence students' motivation and students' use of learning strategies. To examine those variables, we recruited students to complete the combined questionnaire that consisted of the Instructional Feedback Orientation Scale and the Motivated Strategies for Learning Questionnaire. Data analysis showed a significant positive correlation between two dimensions of the instructional feedback and six sub-scales of the motivation and learning strategies. Findings revealed that students' positive feedback perceptions have strong relationships with students' self-efficacy and students' use of several effective learning strategies. These findings suggest the importance of students' feedback perceptions in promoting high levels of self-efficacy amongst the students and supporting the use of effective learning strategies to improve learning.

Students' motivation and use of learning strategies were also investigated in this thesis (Chapter 4). We adopted a mixed-method approach to collect rich data to gain insights in how students perceive instructional feedback and what motivation and learning strategies do students report to apply such instructional feedback. Students participated in semi-structured group interviews and completed the questionnaire simultaneously. During the data analysis we noticed that students were much more confident in their responses about feedback perceptions and motivation, than in reporting learning strategies used. Findings revealed that students experience difficulties using effective learning strategies due to lack of metacognitive awareness of relative effectiveness of such strategies. Data from semi-structured group interviews also indicated radical changes in students' motivation and feedback perceptions as time progressed, however, we did not collect quantitative data at the end of the semester to support these findings. We encourage to repeat the experiment with second quantitative data collection to confirm the results found in this study.

In the final study, we switch the focus from students to instructors and teaching assistants (Chapter 5). There is strong scientific evidence that instructors' individual attitudes towards

certain feedback practices result in such practices being used. Therefore, we were interested in what attitudes towards instructional feedback do instructors have themselves – in other words, what feedback perceptions do instructors and teaching assistants demonstrate, and how those feedback perceptions are reflected in the choice of feedback practices that are present in Computer Science program. We engaged into semi-structured individual interviews with five instructors and three teaching assistants that teach Computer Science to the first-year bachelor students. Data analysis showed that instructors and teaching assistants face difficulties scaling up educational innovations, regarding feedback practices. Results showed strong preference of grading amongst the instructors and teaching assistants. Instructors demonstrated negative feedback perceptions resulting in such beliefs as for example: (1) effective feedback needs to be personalized; (2) effective feedback requires time, effort and resources that majority of instructors report to not have; and (3) feedback needs to be tangible else students will ignore it. Such feedback perceptions lead to strengthening of use of certain feedback practices, such as for example, summative feedback practices, and neglecting of other feedback practices, for example formative feedback practices. Findings also revealed that according to instructors themselves, extensive use of summative feedback practices is not linked to instructors' indifference towards students' learning, but rather it is linked to instructors' self-proclaimed lack of expertise. These insights highlight the importance of investigating instructors' feedback perceptions separately from comparing those perceptions to students' feedback attitudes, and investigating the reasons behind instructors' difficulties in scaling-up educational innovations.

Together, these four studies provide a unique view on feedback perceptions and what role do feedback perceptions play in student learning from both students' and instructors' perspectives. These four studies demonstrate the complexity of feedback process for students and for instructors. On one side, this research highlights the need to investigate feedback the role of perceptions on students' learning from students' perspective, since students hold an individual agency in deciding to whether or not to engage with

instructional feedback. On another side, this research also focuses on the need to explore the role of feedback perceptions on students' learning from instructors' perspective, since the results of this research demonstrate that certain feedback perceptions amongst the instructors and lack of expertise teaching in limiting conditions are translated into overuse of certain feedback practices, even if such practices are not beneficial for student learning. Together, four studies provide insights in students' learning in the context of a large class in Computer Science education during the first semester, which is considered crucial period for students' study success. Therefore, the studies additionally reveal the importance of the context of the study in order to gain authentic insights on effective students' learning. Furthermore, investigating multiple perspectives from students and instructors seem to be effective strategy to advance the understanding of feedback perceptions in Computer Science education.

While the small-scale setting of this research together with limited data collected proved valuable for investigating feedback perceptions in the context of a large class in Computer Science education, further research is desirable. Follow-up studies could, for example, explore the concept of feedback perceptions, students' motivation and learning strategies in other large learning environments in STEM contexts. Longitudinal study collecting data throughout the entire study period could be beneficial in order to investigate changes in students' feedback perceptions, motivation and utilized learning strategies. Additionally, besides the role of feedback perceptions, further studies could focus on what exactly students do in terms of learning strategies when provided with (various types of) instructional feedback. Subsequent research into the development of expertise of the instructors providing feedback to students is essential for those who seek to support (prospective) Computer Science instructors who work in learning environment with limiting conditions, such as, for example, large class.

This research provides suggestions for scholars investigating the concepts of students' feedback perceptions, motivation and learning strategies (Chapter 6). This research also

yields guidelines for policy makers and instructors of Computer Science education. It draws focus on the importance of understanding the role of feedback perceptions in student learning, while also highlights the essentiality of acknowledging the context of the study as one of the aspects influencing students' feedback perceptions and students' feedback application. This research also highlights the value of explicitly promoting instructional feedback application by means of effective learning strategies amongst the students. Regarding support and development of instructors' expertise, this research emphasizes the potential of engaging instructors in reflective dialog focused on adapting and using educational innovations to facilitate student learning, even in learning environment with limiting conditions, such as for example, a large class. Such strategy does not only support instructors dealing with similar issues, it also provides instructors with safe space to reflect on challenges and seek help solving the issues.

Samenvatting

Het bevorderen van de effectieve betrokkenheid van studenten bij instructiefeedback is een bekend probleem onder docenten, onderwijzers en wetenschappers die de effectieve acceptatie van instructiefeedback door studenten onderzoeken. Leerlingen maken niet altijd gebruik van de instructiefeedback die ze ontvangen. In werkelijkheid negeren leerlingen deze vaak of gebruiken ze deze niet effectief om het leerproces te verbeteren. Eerder onderzoek was gericht op instructeurs die een sleutelrol speelden in dit proces; Daarom zijn veel huidige aanbevelingen, adviezen en richtlijnen gestructureerd rond het ontwerp van het feedbackbericht zelf. Recent onderzoek daarentegen erkent de rol van de student en de individuele keuzevrijheid van de student in het proces van de toepassing van instructiefeedback: elke student beslist of hij al dan niet met instructiefeedback aan de slag gaat en deze wel of niet consequent toepast.

Hoewel het erkennen van de individuele bereidheid van studenten om met instructiefeedback om te gaan een nieuw perspectief biedt op het proces van feedbacktoepassing, brengt het ook veel uitdagingen met zich mee voor docenten en wetenschappers in het veld. Studenten ontwikkelen een individuele houding ten opzichte van instructiefeedback op basis van bijvoorbeeld eerdere ervaringen, relaties met de feedbackgever of zelfs verschillende aspecten van de leeromgeving. Dergelijke houdingen worden feedbackpercepties genoemd. Feedbackpercepties zijn van invloed op de manier waarop studenten de feedback ervaren die hen wordt gegeven, en daarmee op de motivatie van studenten om met feedback om te gaan en deze toe te passen om het leerproces te verbeteren. Het is echter belangrijk om te vermelden dat positieve feedbackpercepties er niet altijd toe leiden dat leerlingen zich bezighouden met instructiefeedback. Het hele proces van feedbacktoepassing begint met de 'juiste' mentaliteit van studenten om instructiefeedback te kunnen herkennen, de motivatie van studenten om feedback te accepteren, feedback te begrijpen, vervolgens over te gaan naar het opstellen van een plan om de ontvangen feedback toe te passen en uiteindelijk een effectieve leerstrategie te gebruiken, om het leren te verbeteren. Bij elke stap van dit proces kunnen studenten te

maken krijgen met uitdagingen die het effectieve feedbacktoepassingsproces verstoren: bij elke stap in het feedbackproces ontstaat er een hele nieuwe verscheidenheid aan problemen die van invloed zijn op de daaropvolgende stappen. Nu het nieuwe concept van feedbackpercepties in de onderzoeken naar voren komt, hebben docenten en wetenschappers echter de kans om het proces achter de toepassing van instructiefeedback beter te onderzoeken en te begrijpen.

Om bij te dragen aan het begrip in het vakgebied van feedbackpercepties bij het leren van leerlingen, en om inspanningen te ondersteunen die gericht zijn op het bevorderen van de effectieve acceptatie van instructiefeedback, probeerde dit proefschrift te onderzoeken wat – het fenomeen van feedbackpercepties, en hoe – de invloed van feedbackpercepties op zowel het lesgeven van docenten en het leren van studenten. Om ons onderzoeksdoel te bereiken, hebben we de feedbackpercepties van studenten, de motivatie van studenten en het gebruik van leerstrategieën door studenten bestudeerd, en vertrouwden we op nauwe samenwerking met een gemeenschap van betrokkenen: docenten computerwetenschappen.

Voor ons eerste onderzoek onderzochten we de feedbackpercepties onder eerstejaars bachelor studenten Computerwetenschappen in de context van een grote klas (hoofdstuk 2). Aspecten van de leeromgeving, zoals bijvoorbeeld eerdere ervaringen met feedback, het vakgebied zelf en de relaties met docenten, zijn enkele van de aspecten waarvan bekend is dat ze de perceptie van studenten over instructiefeedback beïnvloeden. Daarom waren we geïnteresseerd in het verkrijgen van inzichten over hoe studenten instructiefeedback ervaren in een complexe leeromgeving en welke aspecten van deze leeromgeving volgens studenten belangrijk zijn in samenhang met hun feedbackpercepties. Via semigestructureerde groepsinterviews hebben we de ideeën, ervaringen en meningen van de zeventien studenten naar voren gebracht. Uit data-analyse bleek dat de leerlingen instructiefeedback als nuttig en waardevol ervaren, maar dat leerlingen de ontvangen feedback niet gebruiken om het leerproces te verbeteren. Uit het onderzoek kwam een aantal essentiële aspecten naar voren die volgens studenten van invloed zijn op het

waarnemen en toepassen van instructiefeedback. Dergelijke aspecten omvatten bijvoorbeeld de kenmerken van de feedbackgever, de leeromgeving en de feedbackboodschap zelf. Het onderzoek concludeerde dat ondanks positieve feedbackpercepties, leerlingen een breed scala aan redenen hebben om niet in te gaan op instructiefeedback. Bovendien heeft dit onderzoek een grote verscheidenheid aan feedbackpercepties van studenten en de redenen van studenten om instructiefeedback te negeren aangetoond.

In het tweede onderzoek (hoofdstuk 3) probeerden we de relaties te onderzoeken tussen bepaalde feedbackpercepties die studenten vertonen, en een groot aantal aspecten van motivatie van studenten en een verscheidenheid aan leerstrategieën die als gevolg daarvan worden gebruikt. Gezien de grote verscheidenheid aan feedbackpercepties die studenten rapporteren, waren we geïnteresseerd in het onderzoeken hoe deze feedbackpercepties de motivatie van studenten en het gebruik van leerstrategieën door studenten beïnvloeden. Om deze variabelen te onderzoeken, hebben we studenten gerekruteerd om de gecombineerde vragenlijst in te vullen die bestond uit de Instructional Feedback Orientation Scale en de Motivated Strategies for Learning Questionnaire. Uit data-analyse bleek een significante positieve correlatie tussen twee dimensies van de instructiefeedback en zes sub schalen van motivatie en leerstrategieën. Uit de bevindingen bleek dat de positieve feedbackpercepties van studenten sterke relaties hebben met de zelfeffectiviteit van studenten en het gebruik door studenten van verschillende effectieve leerstrategieën. Deze bevindingen suggereren het belang van de feedbackpercepties van studenten bij het bevorderen van een hoog niveau van zelfeffectiviteit onder de studenten en het ondersteunen van het gebruik van effectieve leerstrategieën om het leren te verbeteren.
De motivatie van studenten en het gebruik van leerstrategieën werden ook onderzocht in dit proefschrift (Hoofdstuk 4). We hebben een gemengde aanpak gevolgd om inzicht te krijgen in hoe studenten instructiefeedback ervaren en welke motivatie en leerstrategieën studenten rapporteren om dergelijke instructiefeedback toe te passen. Studenten namen deel aan semigestructureerde groepsinterviews en vulden de vragenlijst tegelijkertijd in.

Tijdens de data-analyse merkten we dat studenten veel meer vertrouwen hadden in hun antwoorden over feedbackpercepties en motivatie, dan in het rapporteren van de gebruikte leerstrategieën. Uit de bevindingen bleek dat leerlingen moeilijkheden ondervinden bij het gebruik van effectieve leerstrategieën vanwege een gebrek aan metacognitief bewustzijn van de relatieve effectiviteit van dergelijke strategieën. Gegevens uit semigestructureerde groepsinterviews wezen ook op radicale veranderingen in de motivatie en feedbackpercepties van studenten naarmate de tijd verstreek. We hebben echter aan het einde van het semester geen kwantitatieve gegevens verzameld om deze bevindingen te ondersteunen. We moedigen aan om het experiment te herhalen met een tweede kwantitatieve gegevensverzameling om de resultaten van dit onderzoek te bevestigen.

In het uiteindelijke onderzoek verleggen we de focus van studenten naar docenten en onderwijsassistenten (hoofdstuk 5). Er is sterk wetenschappelijk bewijs dat de individuele houding van docenten ten opzichte van bepaalde feedbackpraktijken ertoe leidt dat dergelijke praktijken worden gebruikt. Daarom waren we geïnteresseerd in welke attitudes tegenover instructiefeedback docenten zelf hebben – met andere woorden, welke feedbackpercepties laten docenten en onderwijsassistenten zien, en hoe die feedbackpercepties worden weerspiegeld in de keuze van feedbackpraktijken die aanwezig zijn in het Computer Science-programma. We hebben semigestructureerde individuele interviews gehouden met vijf docenten en drie onderwijsassistenten die Informatica doceren aan eerstejaars bachelor studenten. Uit data-analyse bleek dat docenten en onderwijsassistenten moeilijkheden ondervinden bij het opschalen van onderwijsinnovaties op het gebied van feedbackpraktijken. De resultaten lieten een sterke voorkeur voor beoordeling zien onder de docenten en onderwijsassistenten. Instructeurs lieten negatieve feedbackpercepties zien, resulterend in overtuigingen als bijvoorbeeld: (1) effectieve feedback moet gepersonaliseerd worden; (2) effectieve feedback vereist tijd, energie en middelen waarover de meerderheid van de instructeurs zegt niet te beschikken; en (3) feedback moet tastbaar zijn, anders zullen studenten deze negeren. Dergelijke feedbackpercepties leiden tot een versterking van het gebruik van bepaalde

feedbackpraktijken, zoals bijvoorbeeld summatieve feedbackpraktijken, en het verwaarlozen van andere feedbackpraktijken, bijvoorbeeld formatieve feedbackpraktijken. Uit de bevindingen bleek ook dat volgens docenten zelf het uitgebreide gebruik van summatieve feedbackpraktijken niet verband houdt met de onverschilligheid van docenten ten aanzien van het leren van studenten, maar eerder met het zelfbenoemde gebrek aan expertise van docenten. Deze inzichten benadrukken het belang van het onderzoeken van de feedbackpercepties van docenten, los van het vergelijken van die percepties met de feedbackattitudes van studenten, en het onderzoeken van de redenen achter de moeilijkheden van docenten bij het opschalen van onderwijsinnovaties.

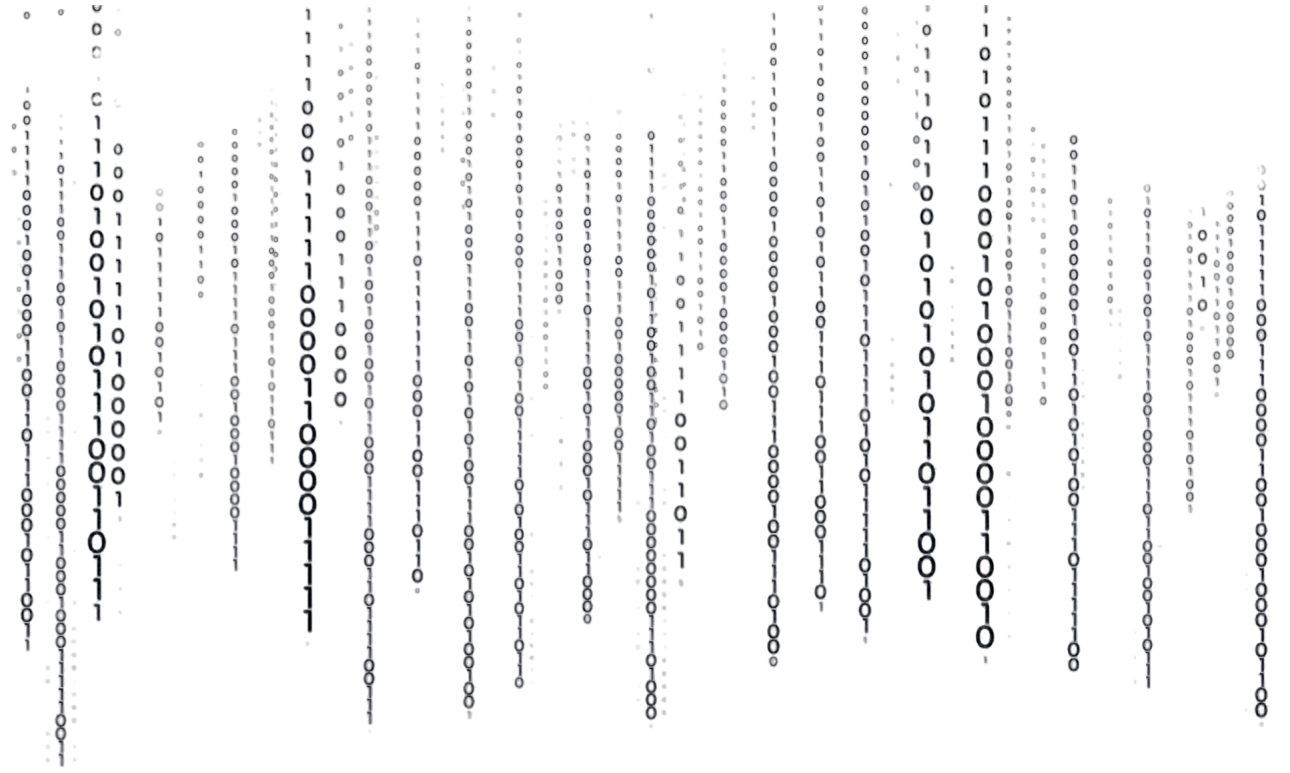
Samen bieden deze vier onderzoeken een unieke kijk op feedbackpercepties en welke rol feedbackpercepties spelen bij het leren van studenten, vanuit het perspectief van zowel studenten als docenten. Deze vier onderzoeken tonen de complexiteit van het feedbackproces voor studenten en docenten aan. Aan de ene kant benadrukt dit onderzoek de noodzaak om feedback en de rol van percepties op het leren van studenten te onderzoeken vanuit het perspectief van studenten, aangezien studenten een individuele keuzevrijheid hebben bij het beslissen of ze al dan niet met instructiefeedback aan de slag gaan. Aan de andere kant richt dit onderzoek zich ook op de noodzaak om vanuit het perspectief van docenten de rol van feedbackpercepties op het leren van studenten te onderzoeken, aangezien de resultaten van dit onderzoek aantonen dat bepaalde feedbackpercepties onder docenten en een gebrek aan expertise in het lesgeven onder beperkende omstandigheden een probleem zijn. Dit vertaalt zich in overmatig gebruik van bepaalde feedbackpraktijken, ook al zijn dergelijke praktijken niet bevorderlijk voor het leerproces van leerlingen. Samen bieden vier onderzoeken inzicht in het leren van studenten in de context van een grote klas computerwetenschappenonderwijs tijdens het eerste semester, wat wordt beschouwd als een cruciale periode voor het studiesucces van studenten. Daarom onthullen de onderzoeken bovendien het belang van de context van het onderzoek om authentieke inzichten te verkrijgen over effectief leren van studenten. Bovendien lijkt het onderzoeken van meerdere perspectieven van studenten en docenten

een effectieve strategie om het begrip van feedbackpercepties in het computerwetenschappelijk onderwijs te vergroten.

Hoewel de kleinschalige setting van dit onderzoek, samen met de beperkte verzamelde gegevens, waardevol zijn gebleken voor het onderzoeken van feedbackpercepties in de context van een grote klas in computerwetenschappenonderwijs, is verder onderzoek wenselijk. Vervolgstudies zouden bijvoorbeeld het concept van feedbackpercepties, de motivatie van studenten en leerstrategieën in andere grote leeromgevingen in STEM-contexten kunnen onderzoeken. Longitudinaal onderzoek waarbij gegevens worden verzameld gedurende langere periode kan nuttig zijn om veranderingen in de feedbackpercepties, motivatie en gebruikte leerstrategieën van studenten te onderzoeken. Daarnaast zou verder onderzoek zich, naast de rol van feedbackpercepties, kunnen richten op wat leerlingen precies doen op het gebied van leerstrategieën wanneer zij (verschillende soorten) instructiefeedback krijgen. Vervolgonderzoek naar de deskundigheidsontwikkeling van de docenten die feedback geven aan studenten is essentieel voor degenen die (aankomende) Informatica-docenten willen ondersteunen die werken in een leeromgeving met beperkende voorwaarden, zoals bijvoorbeeld grote klassen.

Dit onderzoek biedt suggesties voor wetenschappers die de concepten van feedbackpercepties, motivatie en leerstrategieën van studenten onderzoeken (hoofdstuk 6). Dit onderzoek levert ook richtlijnen op voor beleidsmakers en docenten van het Informaticaonderwijs. Het vestigt de nadruk op het belang van het begrijpen van de rol van feedbackpercepties bij het leren van studenten, terwijl ook de essentie wordt benadrukt van het erkennen van de context van het onderzoek als een van de aspecten die de feedbackpercepties van studenten en de feedbacktoepassing van studenten beïnvloeden. Dit onderzoek benadrukt ook de waarde van het expliciet bevorderen van de toepassing van instructiefeedback door middel van effectieve leerstrategieën onder de studenten. Met betrekking tot de ondersteuning en ontwikkeling van de expertise van docenten benadrukt dit onderzoek het potentieel van het betrekken van docenten bij een reflectieve dialoog

gericht op het aanpassen en gebruiken van onderwijsinnovaties om het leren van studenten te vergemakkelijken, zelfs in een leeromgeving met beperkende omstandigheden, zoals bijvoorbeeld een grote klas. Een dergelijke strategie ondersteunt niet alleen instructeurs die met soortgelijke problemen te maken hebben, maar biedt instructeurs ook een veilige ruimte om na te denken over uitdagingen en hulp te zoeken bij het oplossen van de problemen.



Chapter 1. General Introduction

A need of urgency underlies the aim of this dissertation: the need for educators and researchers to acknowledge the importance of students' effective uptake of instructional feedback in higher education.

Feedback is one of the most powerful instructional tools to facilitate students' learning (Hattie & Timpereley, 2007; Evans, 2013; Hattie & Clarke, 2018; Strijbos et al., 2021). However, instructional feedback facilitates learning and improves performance only when it is applied by students (Strijbos et al., 2021; Lipnevich & Van der Kleij, 2020). Due to the common misconception, feedback was long conceptualised as a linear process which implies that when feedback is provided, it is automatically applied (Winstone et al., 2017). In reality, scientific evidence has shown that students do not always recognize instructional feedback, and when students do recognize instructional feedback, they do not always apply it to improve learning (Van der Kleij & Lipnevich, 2020; Van der Kleij et al., 2013). Students' individual factors, such as, for example, relationships with instructor, characteristics of the learning environment, and prior experience with feedback, play a determining role in whether or not instructional feedback will be applied. These factors are conceptualised within the term Feedback perceptions (Van der Kleij et al., 2013). Despite the growing interest in instructional feedback, the concept of feedback perceptions has received limited attention amongst the feedback scholars. Lack of investigations of feedback perceptions in higher education is a serious concern when investigating the feedback as a tool to facilitate students' learning, especially when students' learning takes place within specific conditions of the learning environment, such as, for example, large class, Computer Science context and the first year of the university. Such contextual factors often get overlooked in the general discussion of utility of instructional feedback.

In this dissertation we aim to answer the following overarching research question:
"What role do students' and instructors' feedback perceptions play in students' learning in large groups within Computer Science education?"

Answering this question, we explore the influence of feedback perceptions with the four foci in mind. First focus point explores how students and instructors perceive instructional feedback. The second focus aims to investigate how current students' feedback perceptions are linked with students' motivation and students' learning strategies that are commonly used to apply instructional feedback. Third focal point explores how current feedback perceptions are reflected in instructors' feedback practices that are commonly used to facilitate learning. Last focal point is looking at what specific conditions of learning environment are mentioned in conjunction with feedback perceptions by both students and instructors. Together, those four points paint a 'holistic' picture of the role of feedback perceptions in students' learning in large Computer Science classes.

In the first chapter I introduce a literature review to address the broader context of this doctoral thesis. The literature review includes discussion on feedback and feedback perceptions, students' motivation and students' learning strategies, followed by a reflection on feedback within the context of a large class and the first year in the university. Next, we discuss the rationale of positioning this study within the field of Computer Science education, followed by the case of Delft University of Technology. The main aim and the overview of this dissertation are presented in the final part of this chapter.

1.1. Entanglement of feedback and grading in higher education

Assessment is a term that is used to cover a broad category of all procedures, measurements and tasks used to evaluate the quality of students' learning, instructors' teaching and the quality of the program itself (Boud & Falchikov, 2007). Feedback is a part of assessment procedures. Assessment does not only act as an instrument of quality assurance or ensuring confidence in standards and procedures. Assessment also includes: 1) various types of feedback to monitor students' learning by formative feedback and summative grading, sorting and classification of students; and 2) evaluation of instructors' teaching (Boud & Falchikov, 2007). However, one of the biggest problems related to the term 'feedback' is that it means different things to different people. While feedback includes both formative and

summative purposes of evaluation of students' learning, there is a common misconception amongst the instructors in higher education, that 'feedback' is often linked with summative purposes of students' learning evaluation. The common assumption is that whenever feedback is provided to students, grading of learning ultimately should take place as well, meaning that feedback is often linked with grading (Winstone & Boud, 2020; Chalmers, Mowat & Chapman, 2018). Boud and Winstone (2020) state that such conglomeration of feedback and grading results in 'blurring of their unique purposes' (p.2).

Scriven (1967) defines feedback purposes based on the time of evaluation of students' learning: summative feedback is often represented as a judgement of students' learning after the process of learning, while formative feedback focuses on students' learning while learning is still progressing. Bloom, Hastings and Madaus (1971) differentiate formative and summative feedback by their ultimate goals: summative feedback being a tool to grade and certify the learner; while formative feedback serving as a tool to evaluate the learning and take necessary steps to improve it. However, Rand (2017) and Black and Wiliam (1998) argue that both formative and summative feedback aim to help students improve learning, the main difference lies in tools utilised. The lack of clarity in nomenclature amongst the unique purposes of formative and summative feedback is still ongoing with scholars arguing for both types of feedback being 'the two ends of the same spectrum' (Black & Wiliam, 1998:34), have overlapping functions (Cookson, 2018) or seeing formative feedback as summative feedback with the addition of information (Taras, 2005). Sadler (1989) and Brown and Glover (2006) however, call for explicit acknowledgement of the need to separate formative feedback from summative grading, since grade obscures students' attention from the formative purpose of feedback, which is ultimately, improving learning. Sadler (1989) believes that feedback information that comes with a grade is often perceived by students as a grade justification rather as a direction to improve.

For the purpose of this paper, we use the definition of feedback from Henderson and associates (2019:268) who state that feedback is 'processes where the learner makes sense

of performance-relevant information to promote their learning'. Following this definition, feedback is about information that helps students to move forward in their learning.

1.2. Grading as a dominant feedback practice in higher education

It is important to mention that grading is often given a negative undertone by scholars investigating assessment and feedback in particular. While not serving as a direction for improvement, grades have major influence on students' future and career prospects that often depend on grades that acts as measurable indication of student learning (Boud & Falchikov, 2007). High level academic performance is an aspect included in several student success studies (Ohland et al., 2009; Feng & Graetz, 2017, Naylor et al., 2015; Walker & Zhu, 2011; Kara et al., 2021). Torenbeek et al. (2010) and Kamphorst et al. (2015) include such attribute as a prior achievement in Mathematics to play role in students' success predictions. This means that such a commonplace matter as grades influences the path of learners and contributes to the position a learner can gain.

However, grades have little to no focus on the process of learning itself, neither on how students' future work can be influenced after the moment of grading. From a closer look, the dominant role of grading practices in universities focus around simple ranking and classification of students' achievements basis on measurements of students' current knowledge (Boud and Falchikov, 2007). The fundamental problem with grading being a dominant practice is that it implies that students become passive learners, who rely on assessment acts of others in order to be measured and classified. Seeing students as passive subjects in their own learning does not only remove any sense of responsibility from students to monitor their own learning, it also demotivates students to become active learners, learn to study independently and trust their own judgements regarding the quality of one's learning (Hager & Butler, 1996; Boud & Falchikov, 2007). As a result, grades are seen as the only evaluation tool for students to reflect on their learning.

While adverse effects of grading versus providing feedback on students' learning are obvious to scholars studying feedback for many decades, scholars, educators and policy makers are still struggling with developing feedback practices that facilitate learning (Carless and Boud, 2018; Dawson et al., 2019). According to Boud and Falchikov (2007), this can be partially attributed to the practical risks and consequences involved in changing commonly used feedback practices. Similar conclusion was found by Mao and Crosthwaite (2019) and Lee (2008), who noticed that instructors continue utilizing commonly used feedback practices even if those practices are perceived as ineffective. Authors argue that the development and implementing of new feedback ideas and actual changes in practical application has been a slow process, because it involves risks that not many stake holders are willing to consider, such as, for example additional professional trainings for instructors, financial investments by hiring more teaching assistants, funding educational research, extra work load on teaching staff etc. Matthew Fuller et al. (2013) suggest that a specific culture of assessment that prevails on campus is also responsible for a slow change in feedback practices. Culture of Assessment is the concept that is used to describe the deeply embedded values, beliefs and perceptions about all types of feedback practices collectively held by all members of the university involved in designing, implementing and evaluating those feedback practices (Fuller & Skidmore, 2014). Similar to the Holland's theory on career development[1], the term Culture of Assessment suggests that all members of the university involved in providing feedback to students contribute to the specific perspective, beliefs and values of the way feedback is seen and used in that learning environment. That results in a unique dominant culture of specifically used types of feedback on campus which is difficult to change (Holland, 1966l Fuller et al. 2013).

[1] John L. Holland's theory on career development (1966 and 1997) is a theory on person-environment fit. The Holland's model has three main assumptions: (a) self-selection – students choose academic environments that are compatible with their personality types; (b) socialization – certain academic environments reinforce certain cognitive and behavioral reactions; (c) and congruence – people in environments congruent with their personality types feel fit which is reflected in their career prospects (pp. 51-54).

1.3. Feedback as a tool to enhance students' learning

A famous quote of Hattie and Timpereley (2007) states: "feedback is the key element in students' learning". The research made by Black and Willem (1998) provided evidence that well-implemented formative feedback contributes to students' improved learning and performance. Similar results were collected from the meta-analysis of Hattie (2009): out of 138 feedback practices reviewed, many formative feedback practices, such as, for example self-report grades or peer review and peer feedback, contributed to higher-order learning amongst students. Although being undoubtfully essential for students' learning, recent research shows growing students' dissatisfaction with current feedback practices utilized in higher education (Williams & Kane, 2009). Students' concerns include such aspects of feedback as fairness; lack of clarity on what is expected from students to achieve; emotional dissatisfaction on a mismatch between students' expectations and reality when receiving feedback; prior negative experience with feedback and anxiety; timeliness of feedback and its utility (Carless et al., 2017; Jessop et al., 2014). Due to the increasing number of complaints from students regarding instructional feedback, it was safe to conclude that there is a missing link between the instructors' intentions when providing feedback to students, and what students actually do with instructional feedback.

1.4. The missing link

For a long time, feedback was seen as a linear process – it was assumed that students automatically act upon instructional feedback (Winstone et al., 2017). In contrast with this view, scholars are working to redefine feedback as a process in which learners make sense of provided information and use it to change their behaviour to improve the quality of their work (Henderson et al., 2019; Carless, 2016, Winstone et al., 2017). However, practice shows that students do not always act in response to instructional feedback (Evans, 2013; Bailey and Garner, 2010). In other words, there is a missing link between feedback that is provided by instructors and feedback being applied by students.

Van der Kleij et al. (2015) explored the missing link, which led to the concept of feedback perceptions. According to Van der Kleij et al. (2015), feedback perceptions are all the external and internal attributes that influence whether feedback is recognized and/or applied by feedback receiver. External attributes include, but are not limited to: students' relationships with instructors, characteristics of learning environment, personal and learning environment resources, relationships with peers, prior experience with feedback and assessment practices. Internal attributes include but not limited to: students' beliefs about feedback and themselves, students' mental and physical wellbeing at the moment of receiving feedback, students' motivation and attitudes towards learning (van der Kleij et al., 2015). All these attributes create a dynamic interplay of interpersonal, organizational and societal factors that influence how students react on instructional feedback and what are their consecutive actions (Ivankova and Plano Clark, 2018).

Although feedback perceptions are a relatively new term, this concept can be traced back to works of Black and Wiliam (1998:20-21), who argued: "There are complex links between the way in which the message is received, the way in which that perception motivates a selection amongst different courses of action, and the learning activity which may or may not follow". In other words, the concept of feedback perceptions that play role in students' learning is not new, however, we believe it is not yet tackled appropriately.

1.5. Feedback perceptions and students' motivation

Black and William (2009) and Butler and Winne (1995) have shown that feedback perceptions influence students' cognitive and behavioural responses. When provided with instructional feedback, students decide whether or not they should act on it. Students' motivation to engage with instructional feedback has been studied for many decades (Carless and Boud, 2018; Fong et al., 2018; Winstone and Carless, 2019). However, the concept of feedback perceptions and its influence on students' motivation have only been conceptualised from the prism of feedback constructivism (Fong et al. 2021; Fong et al., 2016). Since feedback perceptions are highly individualistic; it is hard to define feedback

constructivism in a one-fits-all approach. In other words, based on the individual perceptions of the feedback receiver, the exact same feedback can be seen as both constructive and threatening for two different students (Fong et al., 2016; van der Kleij et al., 2015). Fong et al. (2021) attempted to provide guidelines for constructive feedback. Authors included nearly axiomatic principles of constructive feedback by Hattie and Timperley (2007): feedback should be timely, specific and process-focused; and added a principle of feedback providing directions for improvement as well as layer of sensitivity: politeness, positivity and 'friendliness' of the feedback message (Fong et al., 2016). These guidelines were associated with positive results: Schunn and Wu (2020) reported that students tend to agree with feedback when it is positively worded. However, Schunn and Wu's and Fong et al. line of argument follows the familiar misconception about feedback's linearity: implying that the instructors are responsible for students' applying or ignoring instructional feedback since the instructors are responsible for crafting instructional feedback appropriately. This line of reasoning focuses extensively on the quality of the instructional feedback and ignores other aspects of students' feedback perceptions.

Carless and Boud (2018) suggest that students' motivation to engage with feedback does not only depend on the content of feedback message, but also on students' goal orientation and students' feedback literacy. This suggestion resonates with the literature on students' goal orientation theory (Dweck and Leggett, 1988; McKeachie, Pintrich, Lin and Smith; 1986; Elliot and Church, 1997). McKeachie et al. (1986) define students' goal orientation as the purpose of engagement with a certain task. According to these authors, students' motivation depends on: a) intrinsic goal orientation as focus on developing competence and understanding, b) extrinsic goal orientation as focus on demonstrating competence in comparison with others, and c) relevance and value of the task itself.

Student's feedback literacy resonates with social-cognitive theory provided by Bandura (1997), Schunk and DiBenedetto (2016) and Winstone et al. (2017). Authors describe student's feedback literacy as students' ability to effectively interpret feedback, which is

ultimately a self-efficacy. Self-efficacy as feedback construct includes "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997:3). These beliefs include a) one's judgements of one's ability to accomplish the task, b) beliefs that efforts invested in learning result in positive outcomes, and c) feedback-related worried and anxiety (McKeachie, Pintrich, Lin and Smith, 1986).

It is safe to conclude that the relationship between students' motivation to engage with provided feedback and students' feedback perceptions are reciprocal, meaning that feedback perceptions do not only influence students' motivation to engage in learning, but are also interpreted differently depending on one's level of motivation: goal orientation and self-efficacy (Winstone et al., 2017). Usher and Pajares (2008) support this statement saying that such relationships are of a particular importance when communicating feedback to students that are not yet skilled in accurately assessing their abilities, competences, skills and knowledge. When conflicting with one's current goals and beliefs about the self, feedback may be perceived as offensive, reduce one's confidence and motivation, and as a result, ignored (Hattie and Timperley, 2007).

1.6. The connection between feedback perceptions and learning strategies

Ideally, feedback perceptions help students realize that they need to adapt their knowledge, their beliefs and learning strategies to improve learning (Black and Wiliam, 2009; Van der Kleij and Lipnevich, 2021). However, feedback perceptions do not always contribute to students' positive change of behaviour. As an example, students may ignore feedback or engage in learning strategies that do not enhance learning (Dunlosky and Rawson, 2015).

Learning strategies are students' tactics, actions and steps that learners take when they utilize feedback (Black and Wiliam, 2009). The intentions and goals behind those actions are to enhance performance and to improve learning, although the results of different learning strategies may vary significantly. This is due to another misconception, namely that students come to university prepared to learn independently and knowing exactly how to learn to

achieve their learning goals (Bjork et al., 2013). Universities often expect students to be able to direct their own learning productively, meaning that students can set their learning goals, evaluate current knowledge and skills, identify the gap of missing knowledge and acquire competences to close this gap (Bjork et al., 2013). However, choosing task-appropriate, productive learning strategies is a skill on itself. Bjork et al. (2013) argues that such skill is not natural to learners, neither it is explicitly taught to students. This argument is also supported by Dunlosky et al. (2013:46), stating: "…students are not instructed about which techniques are effective or how to use them effectively during formal schooling." As a result, students are often unaware of various learning strategies, let alone what makes those strategies productive or unproductive for learning.

Given the amount of information that students need to master across a wide variety of courses at universities, it is important to strive for using one's time productively. Dunlosky and Rawson (2015) argue that the purpose of regulating one's own learning is to enhance learning by utilizing effective control of study. However, practice shows that students often underutilize productive learning strategies, while overutilizing other, unproductive learning strategies (Dunlosky et al., 2013). An example of that can be students relying on simple memorization of the material, without attempts to understand the concept and to practice the learnt skill. To support the authors' arguments, they explored the impact of ten different learning strategies that students often use and studied the effectiveness of those learning strategies as in achieving students' learning goals. To maintain the concept of learning independently, learning strategies chosen by the authors had to meet three criteria: (1) following learning strategies that prove to improve students' success basis on literature studies, (2) following learning strategies that are used frequently as reported by students, and (3) following learning strategies that can be easily implemented by students themselves with no assistance required (Dunlosky et al., 2013). Ten learning strategies that satisfy these three criteria, together with their level of productivity for students to achieve learning goals

are presented in table 1.1:

Table 1.1. Evaluation of most frequently used learning strategies and their utilities

Learning strategy	Productivity of a learning strategy
Practice testing	High
Distributed practice	High
Interleaved practice	Moderate
Elaborative interrogation	Moderate
Self-explanation	Moderate
Summarization	Low
Highlighting	Low
Keyword mnemonic	Low
Imagery use for text learning	Low
Rereading	Low

Adapted from Dunlosky et al. (2013:45). Productivity of learning strategies as related to students' achieving their learning goals.

Even though these learning strategies are quite versatile, the authors point out that the goal is not to define the most effective approaches of learning and stick to such ways. The goal is to educate scholars, educators and policy makers about how students engage in learning and what can be done to facilitate students' learning. According to Dunlosky and Rawson, (2013), most students engage in learning strategies with low impact on students' learning. In Table 1.1. these are the learning strategies that have the low utility level regarding students' achieving learning goals. Dunlosky and Rawson (2013) found that rereading and highlighting are the two learning strategies that are endorsed by most students. Although Bjork et al. (2013) claims that students' commitment to ineffective strategies is a flaw of the educational system, Dunlosky et al. (2013) argues that instructors themselves are not educated sufficiently about the efficacy of various learning strategies.

Moreover, neither educators nor scholars professionally evaluate the learning strategies offered by the literature and textbooks (Pressley et al., 1989). Evaluating, investigating and developing effective learning strategies requires effort, time and sometimes even involves costs, while the premium of resources available to instructors is placed mostly on content and skills related to that content (McNamara, 2010). McNamara argued: "…there is an overwhelming assumption in our educational system that the most important thing to deliver to students is content" (2010:341). The problem of that focus is that, when supervised, students tend to do well in their learning, while, when left to study independently, students are left behind not being able to regulate their own learning process or not knowing how to do that effectively (Dunlosky et al., 2013). Although supporting students in developing effective learning strategies is crucial, it is important to consider potential challenges and limitations of a learning environment in which learning takes place.

1.7. Feedback in large classes

While in the majority of learning environments students are encouraged to ask questions or ask for additional feedback, the large class learning environment significantly limits these opportunities (Kara et al., 2021; Mulryan-Kyne, 2010; Maringe & Sing, 2014, Hornsby & Osman, 2014; Bandiera et al., 2010). It is important to point out that in educational research such term as 'large class' is given a negative shade (Hornsby et al., 2013). Large class is described as a "…learning environment where the quality of student learning may be impacted, negatively, by the number of students in the class" (p.8). The research into teaching and learning in large groups often focuses on the quantity of the resources available, and not on the quality of those resources (Bransford, Brown, & Cocking, 2000; Hattie, 2008). That means that in terms of feedback, there is a common strategy in large groups to increase the amount of feedback that students receive from instructors, while scientific evidence also suggests that abundance of feedback results in students becoming reluctant to any instructional feedback (Bransford, Brown, & Cocking, 2000; Hattie, 2008). Since students' feedback perceptions determine how feedback is perceived by students, and

whether or not feedback will be applied (van der Kleij et al., 2015), students' passivity towards instructional feedback becomes a significant concern. Inability to perceive instructional feedback adequately leads to increased risks amongst students to not engage in learning productively, which is especially crucial during the first year at the university, since it lays the fundament for future study success (Ohland et al., 2009; Feng & Graetz, 2017).

1.8. The importance of the first year at the university

First year at the university is often seen as the most challenging time for undergraduate students (Hodgson et al., 2010; Bangser, 2008). Students leave the well-defined structured learning environment of secondary education and step into the new, unknown learning environment of the higher education. Next to psychological discomfort due to the rapid changes in students' personal lives, there is the high pressure to perform and to achieve (Sheppard, Macatangay, Colby & Sullivan, 2009). Scholars studying student success model predictions postulated that students who succeed to keep their academic performance on the highest level during the first year, tend to continue to do so throughout the entire study duration (Kara et al., 2021; Naylor et al., 2015; Walker & Zhu, 2011). For that reason, many researchers (Toa et al., 2000; Bjork et al., 2013; Coertjens et al., 2017) stress the importance of providing adequate support to students during the first year. Adequate support also includes providing students with instructional feedback that acts as an evaluation for students to reflect on the quality of their learning (Boud & Falchikov, 2007; Carless et al., 2017). Yet, Bjork and associates (2013), warns the scholars that freshmen students simply lack skills and knowledge to evaluate their own learning (Cervin-Ellqvist et al., 2020). This leads to instructional feedback to be seen as a tool to measure knowledge and students' cognitive abilities instead of providing guidelines for improvement (Boud & Falchikov, 2007; Carless et al., 2017). According to Robinson et al. (2013) as a result of this mismatch between the expectations of the university and students' skills and knowledge, both students and instructors often focus on grades as the main type of instructional feedback.

2. **Computer Science education as the focus of this research**

Despite the recent advances in the field of feedback in cognitive science, feedback in Computer Science education has received limited attention. While educational and pedagogical challenges in Computer Science education and other fields often overlap, some of the differences were considered crucial (Haghighi, 1998; De Graaf & Ravenstijn, 2001). It is important to recognize that such aspects, as students' personal attributes, curriculum design and culture on campus vary significantly amongst different fields (Becher 1994; Umbach, 2007; Ashwin, 2006; Smart et al., 2010; Lattuca et al., 2010, Henderson et al., 2017). It is not only students, who represent the specific sub-culture on campus, but also the university staff that represent a certain sub-culture that overlaps with the disciplinary culture. In terms of feedback, Roselli and Brophy (2006) concluded that across STEM[2] field, under which Computer Science settles, feedback is mostly summative in nature. Moreover, during learning to program in the majority of Computer Science programs, feedback is often given automatically on errors in codes or syntax errors, which do not cover the fundamental underlying concepts of those errors (Keuning et al., 2019). As a result, learning Computer Science becomes particularly difficult because initially programming is not only a body of knowledge but also a skill that requires understanding of the concepts deeper than the surface-level (Jenkins, 2002). According to author, it is not enough to learn the syntax of the codes or the programming language itself. Programming requires understanding of the fundamental concepts, demonstration of problem-solving and mathematical skills. Especially, considering that object-oriented programming is the core of Computer Science education. Compared to PP (Procedural Programming), OOP (Object-Oriented Programming) is typically more difficult to learn for beginning students since it requires understanding of the abstract concepts and implementing a different way of thinking about problems (dealing with interactions between objects, syntax, structure or encapsulation and access control) (Bennett, McRobb & Farmer, 2010; Maciaszek, 2017).

[2] STEM is an acronym, consisting of four disciplines: Natural Sciences, Technology, Engineering and Mathematics (Wikipedia, 2024). Computer Science in STEM falls under the umbrella of Software Development which is a part of Technology major

Commonly used automated feedback does not provide an opportunity for students to gain that necessary understanding of fundamental concepts (Silva et al., 2021; Robins 2019; Koulouri et al., 2015; Milne & Rowe, 2002; Islam et al., 2019; Karaca et al., 2017; Nuutila et al., 2008). Besides limited applicability for improved learning, automated feedback is also not given timely to students. Jansen et al. (2017) postulated that due to the time constraints, students usually get feedback on code quality after the assignment is submitted. Such feedback is not only unapplicable, it also does not provide any directions for further improvement, which makes it difficult for students to choose productive learning strategies to improve learning. As noted by Cervin-Ellqvist and associates (2020), students in STEM fields often use ineffective learning strategies, such as, for example rereading and highlighting that were summarized by Dunlosky and Rawson (2013) to be of the low-efficiency. Authors also noticed that almost all learning strategies were ranked as moderately effective by students in STEM contexts, even those learning strategies that had low effectiveness on students' learning. Cervin-Ellqvist et al. (2020) claim that students' individual beliefs are responsible for engaging in ineffective learning strategies: students simply believe that such learning strategies are useful for learning. First, this observation exemplifies students' lack of skills and knowledge in choosing effective learning strategies; and second, this observation also highlights the importance of context of Computer Science in terms of students' experiences of learning. Inability to learn effectively is a crucial setback in STEM field, where curriculum is strongly scaffolded. A scaffolded curriculum means that once lacking substantial understanding in a core subject, it becomes progressively more difficult for a student to catch up with other subjects (De Graaf & Ravenstijn, 2001; van der Bogaard, 2015). As a result, students struggle studying, spend more time finishing the study or drop out from the program, which is not uncommon amongst the STEM fields. In fact, according to Kuzilek et al. (2023), Kabra and Bichkar (2011), students' drop-out rates amongst STEM fields are one of the highest compared to non-STEM fields. Kuzilek et al. (2023) also suggests that during the introductory courses students struggle the most, due to the high failure rates, and these struggles results in students feeling demotivated and discouraged to continue their program. This statement once again highlights the

importance of receiving adequate support and appropriate feedback during the first year in university. First year in Computer Science means that students spend a lot of time practicing coding, even when those assignments are not graded (Jenkins, 2002; Lopez-Fernandez et al., 2015). During this time, students rely on instructional feedback to evaluate their learning progress, however, research shows that instructors of Computer Science often lack pedagogical skills and knowledge to enhance learning by means of feedback (Tucker et al., 2007). Although the requirements to demonstrate mastery in both content and pedagogical knowledge are not unique to Computer Science, but also true to all other fields, for example Law and Medicine, scientific evidence shows that instructors in Computer Science are often not adequately prepared in pedagogical skills and knowledge (Gal-Ezer & Harel, 1998; Won Hur, 2019; Hazzan et al., 2020; Dagiene & Futschek, 2019). That means that instructors do not always know how to adapt pedagogical tools, approaches and competences to the conditions of their unique learning environment (Ragonis, & Hazzan, 2019; Haberman & Ragonis, 2010; Dagiene & Futschek, 2019). Boud and Molloy (2012) postulate that when instructors do not have sufficient training and experience, the quality of learning might be heavily compromised.

3. **The case of Delft University of Technology**

Delft University of Technology holds a respectable position amongst the top technical universities in the world: it is considered the leading innovative institution in engineering and design in the Netherlands, while it also maintains high position amongst the prestigious international universities (QS World University Ranking). Great reputation requires equally great efforts to successfully prepare and educate future engineers. Such high expectations put extra pressure on both students and instructors of Delft University of Technology. Engineering students all over the world struggle with learning complex engineering concepts effectively, which results in students taking much more time to graduate compared to nominal duration of the programs at the university, or, in a worst-case scenario – leaving the university before the graduation (Seymour et al., 2019; Sheppard et al., 2009; Van den Bogaard, 2015). Recent graduation numbers within Delft University of Technology

(57%) show a similar trend mentioned by Seymour et al. (2019) and Sheppard et al. (2009) when almost half of the cohort takes more than nominal duration of years to complete the bachelor degree. In 2024, almost one third of engineering students (32%) are still completing their bachelor degree started in 2020 [Facts and Figures, 2024]. Besides students struggling with learning, instructors also experience difficulties adapting the highly concentrated content of the courses and innovative teaching approaches to the conditions of their own unique learning environment (Carless, 2017; McLaughlin, 1991; Anderson et al., 1987; Cannata & Nguyen, 2020). The adapting to students' needs and the ability to translate those needs into educational approaches is a well-known issue amongst instructors all over the world (Kahu & Nelson, 2018). Such challenges are not unique to instructors of Delft University of Technology (Kamp, 2023). Switching from programs taught in Dutch to programs taught in English by several faculties has contributed to rapidly growing number of students within a Computer Science program: as international students came to the university, classes became bigger, sometimes three times the initial size. Large classes, combined with overloaded curriculum and highly paced lectures, led to fewer opportunities for instructors to regularly interact with the students while adequate support during the first year in the university is crucial for students to succeed in learning (Kahu & Nelson, 2018; Tinto, 1993). Large classes and time constraints also led to fewer opportunities for instructors to communicate with students. Familiar question: 'Why do I have an 'eight' and not a 'ten'?' exemplifies the lack of clarity that students experience from instructional feedback.

Delft University of Technology has strived to invest in technological research and innovations, however, not much focus was directed to educational innovations (TU Delft AI Initiative, 2024). Over the last decade many studies were focused on understanding specific problems and issues related to teaching and learning at Delft University of Technology and to feedback specifically. Several faculties attempted to introduce various pedagogical innovations and interventions to their own programs to enhance students' learning for their courses. However, the majority of the interventions focus on the quantity of the required

resources, and not on the quality of those resources. For feedback, the most common strategy becomes to increase the amount and frequency of feedback that students get, but not to improve or adjust the quality of such feedback (Nicol & Macfarlane-Dick, 2006; Shute, 2008; Hattie & Timperley, 2007).

While students not recognizing instructional feedback and not applying it effectively to improve learning is a universal issue across many different fields, limiting conditions of large Computer Science class makes a strong case to investigate feedback and feedback perceptions in the context of large Computer Science class as a focus of this study. Such limiting conditions are, for example, limited opportunities for individual attention, reduced interaction, challenges in providing timely feedback, difficulties in implementing active learning techniques or other educational innovations, classroom management and other assessment and grading constraints (Mulryan-Kyne, 2010; Nieminen & Carless, 2023; Freeman et al., 2014). Similar challenges, in particular limited ability of instructors to provide personalized feedback in large groups, strong focus on so-called traditional lecture-based format of teaching and difficulties providing timely feedback, were mentioned in various studies within Computer Science bachelor program (Watson & Li, 2014; Robins et al., 2003; Bennedsen & Caspersen, 2007).

As mentioned by Lattuca et al. (2010), there is substantial scientific evidence that resistance to educational reforms has roots in contextual differences: in order to facilitate change, it is important to recognize, reflect upon and address deeply embedded values and ways of thinking amongst students and instructors of Computer Science education.

4. **Research aim**

This dissertation focuses on exploring and understanding the complexity and multidimensionality of feedback in large classes within Computer Science program. Complexity of feedback refers to the range of feedback's nature, purposes and processes explored in this dissertation, while multidimensionality of feedback refers to the wide range

of feedback perceptions acquired through the studies. In other words, we investigated what – the phenomenon of feedback perceptions, and how – the influence of feedback perceptions on both instructors' teaching and students' learning. We also dived deeper in the context of this dissertation, because as stated by Smart (2010), Smart et al. (2009), and Lattuca et al. (2010), the context and personality types are highly correlational. We explored both students' and instructors' perspectives of how the learning environment of Computer Science program and large class setting influence students' feedback perceptions, motivation and learning strategies during the first semester at the University – a transition period for students. To obtain data from students and instructors, quantitative and qualitative methods were used. To answer the main question: "What role do students' and instructors' feedback perceptions play in students' learning in large groups within Computer Science education?", four studies were performed. For all our studies we extensively relied on collaboration with instructors of Computer Science program to meet our goal. While quantitative data allowed us to explore patterns and find correlations between variables, qualitative data allowed us to gain in-depth insights on feedback perceptions, motivation and learning strategies, which helped us to complete the whole picture. The collaborative nature of the project allowed us to work closely with the instructors directly involved in teaching first-year undergraduate students in a relatively novel for instructors setting – a large class. As a result of this collaborative approach, we were able to get support and guidance in recruiting both students and teachers for our project to meet our research aim. Close interactions with the teaching community additionally enabled to stay 'up to date' with the needs and requirements of the rapidly changing new learning environment for both students and instructors.

5. **Dissertation outline**

To meet the aim of this thesis, four studies were conducted that explored students' and teachers' perspectives on feedback, motivation and learning, in which (a) a preliminary analysis and an overview of students' feedback perceptions, experiences and thoughts of feedback that they receive in the new learning environment (Chapter 2);

(b) an in-depth analysis of students' feedback perceptions and the influence of feedback perceptions on students' motivation and learning strategies are investigated (Chapter 3);
(c) the perceptions, experiences and thoughts of students on feedback, motivation and learning strategies in new learning environment are described (Chapter 4); and
(d) instructors' and teaching assistants' perceptions of instructional feedback and the reflection of those feedback perceptions on commonly used feedback practices in large classes of Computer Science program are explored (Chapter 5).

All four studies are presented in-detail in subsequent chapters. Short explanations of the studies are presented below:

Chapter 2 provides an initial qualitative study that draws preliminary insights about students' feedback perceptions. The main research question for this study is: How do first-year bachelor students of Computer Science perceive feedback? Unlike similar studies in feedback field, we used different approach to collect the data – we conducted semi-structured group interviews to gain in-depth insights on students' opinions, thoughts and experience with feedback practices (Creswell, 2009). Group interviews were held three times throughout the first semester: (1) in the beginning of first semester – to capture the starting point of students' experiences, (2) in the middle of the first semester to seize any potential changes amongst students' experiences with feedback, and (3) in the end of the first semester to apprehend the fluctuations in students' attitudes and experiences towards feedback, compared to the starting point. In total, 17 first-year undergraduate students of Computer Science participated in all three rounds of interviews. Collecting data by means of interviews was chosen because we initially wanted to drop the assumptions of feedback's direct and linear nature (Winstone et al., 2017). Without assuming that students are familiar with feedback, do recognize feedback and apply it accordingly, we were able to collect students' first-hand perceptions, ideas, thoughts and opinions regarding feedback practices that they experienced.

In Chapter 3, students' feedback perceptions are explored in relationships with students' motivation and learning strategies. Since feedback perception influence whether students apply instructional feedback (Van der Kleij et al., 2015), this study sought to investigate what learning strategies are utilized by students and what learning strategies are ignored. Additionally, we explored relationships between students' feedback perceptions and students' motivation. The second study addressed the research question: What are the associations between feedback perceptions and learning strategies amongst first-year bachelor students of Computer Science? To answer this research question, the following sub-questions were formulated: (1) What feedback perceptions do first-year undergraduate students of Computer Science have?; (2) What motivation and what learning strategies do first-year undergraduate students of Computer Science report?; (3) Are there differences in students' feedback perceptions, motivation and students' learning strategies between males and females, students of different educational backgrounds, students' average Mathematics grade, as those personal attributed are known to have impact on student success (Torenbeek et al., 2010; Kamphorst et al., 2015; Torenbeek, 2011; Zhao et al., 2021)?. To answer the main question, we combined the Motivational Strategies for Learning Questionnaire and the Instructional Feedback Orientation Scale questionnaire. Combined questionnaire on students' motivation, feedback perceptions and students' learning strategies was distributed amongst all first-year undergraduate students of Computer Science program. Multilevel analyses were employed, based on 101 returned questionnaires of students.

Chapter 4 focuses on thorough analysis of students' feedback perceptions, motivation and students' use of learning strategies in the transition period in large class. This study zooms in on how students perceive instructional feedback that is provided to them and how do students apply such instructional feedback. In particular, this study investigated what motivation and learning strategies students report to apply instructional feedback that they receive, taking into account students' feedback perceptions. This study was guided by two main research questions: (1) "How do students of large classes in

Computer Science program perceive instructional feedback?"; and (2) "What learning strategies and motivation do students of large classes in Computer Science program report for applying the instructional feedback they receive?". To answer these research questions, both quantitative and qualitative data collection methods were: the self-report questionnaire and semi-structured group interviews with students. Data was collected simultaneously during the first semester: questionnaire was distributed at the same time with first group interviews taking place. This allowed us to triangulate the results obtained in both data collections: we were able to compare and pinpoint students' questionnaire responses to elaborations from the interviews (O'Cathain et al., 2010; Heale and Forbes, 2015; Creswell and Clark, 2018; Johnson et al., 2020; Clark et al., 2003; Morse, 1991).

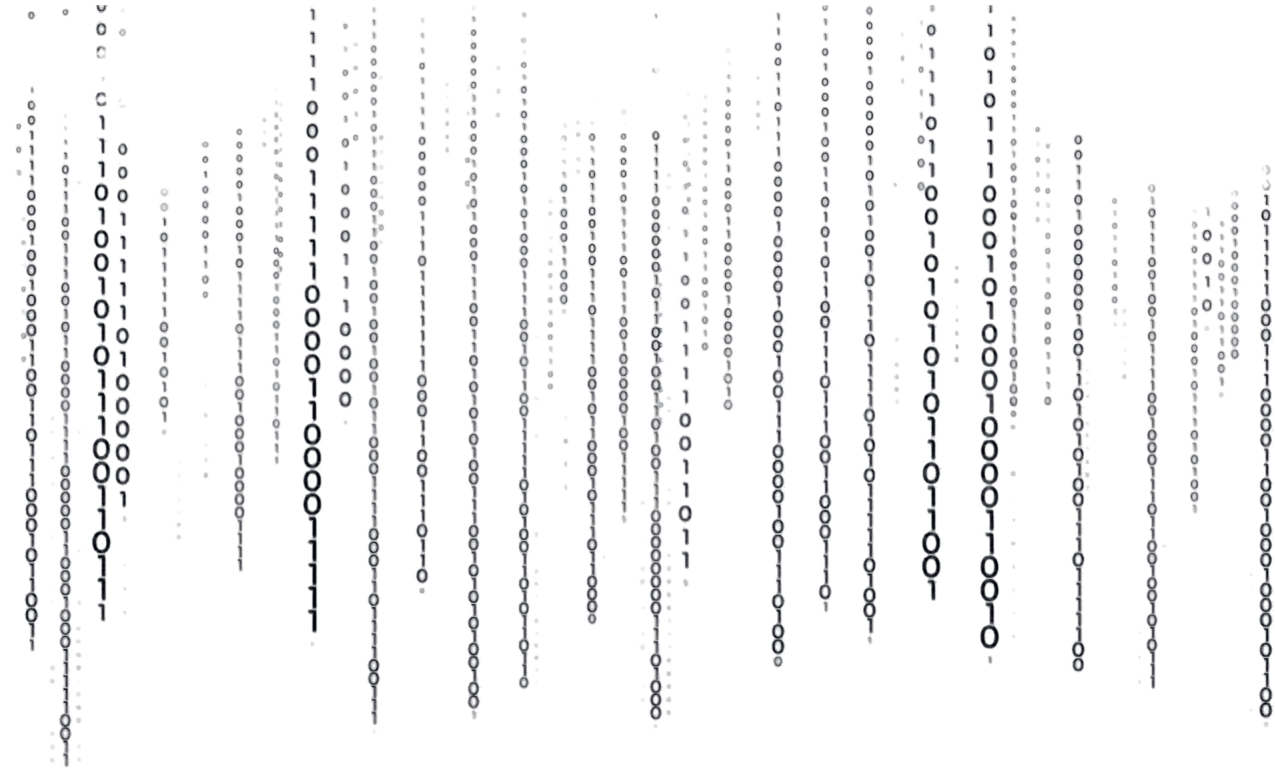
While the first three studies explored students' perspective on feedback, motivation, learning strategies and context, the fourth study focused on instructors and teaching assistants. Chapter 5 examines instructors' and teaching assistants feedback perceptions in a complexity of a large class in Computer Science context, and how those feedback perceptions and aspects of learning environment are reflected in instructors' and teaching assistants' choice of feedback practices, teaching methods and approaches that facilitate learning. This study addressed the following questions:

(1) What feedback perceptions are reported by the instructors and teaching assistants within Computer Science learning environment?

(2) How are instructors' and teaching assistants' feedback perceptions reflected in the types of feedback practices used in large classes in Computer Science program?

Semi-structured individual interviews with 5 instructors and 3 teaching assistants were conducted. All participants of the interviews are directly involved in teaching first-year undergraduate students of Computer Science. Using in vivo coding, combining inductive and deductive methods interviews were analysed.

Chapter 6 is the final chapter of this thesis. It provides a summary of the main findings of chapter 2 to 5, a general discussion of the results, addresses limitation, provides practical implications of four studies mentioned above, and suggests directions for future research.



Chapter 2. Feedback perceptions

Preliminary analysis of semi-structured group interviews with first-year bachelor students of Computer Science

This chapter has been published in adapted form as:

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2.1. Introduction

Feedback is an important part of the learning process and has been studied intensively over the past decades. As a result, there is a large body of knowledge available to researchers and practitioners on ways of making feedback more effective for learners (Boud & Molloy, 2012; Miles & Huberman, 1994; Mulryan-Kyne, 2010). However, literature suggests that teachers and students might have dissimilar experiences of what is considered "effective feedback" (Strijbos, Pat-El & Narciss, 2019; De Laet et al., 2016). One of the reasons is that quite often teachers and students have different feedback perceptions (Boud et al., 2018).
In recent years the number of students pursuing a degree in engineering increases rapidly (VSNU, 2021) also in Delft University of Technology. In 2018, the enrolment of first-year students in Computer Science at Delft University of technology almost quadrupled, from 200 to 800 students (VSNU, 2021). Neither faculty nor students were ready for such changes. As of 2019, a selection procedure numerus fixus was introduced to cap enrolment. This selection procedure consists of three different parts needed to be completed by all applicants: non-cognitive skills assessment; cognitive skills test and self-reflection assessment. However, even with the max cap, the classes at Computer Science are still large: over 500 students. This creates a challenge for the program to provide students with effective feedback.

We decided to study the student needs for feedback from a feedback perception perspective to gain more understanding of what type of feedback the students would benefit most from. In this paper we present our preliminary findings.

2.2. Literature review

2.2.1. Conceptualizing feedback perceptions

According to De Kleij et al. (2013:1014), feedback perceptions are: "…thus concerned with how a learner perceives feedback, which is assumed to be influenced by the feedback message, characteristics of the feedback provider and the frame of reference of the feedback receiver." Feedback perceptions are very individual; however, they are the main

cognitive constructs that guide such processes as achieving learning outcomes and constant learning improvement (De Laet et al., 2016; Carless, 2006; Carless, 2013; Tinto, 1993).
There is an extensive body of literature on feedback and feedback perceptions. Studies tend to focus on both students' and teachers' perspectives: several authors explored whether students' and teachers' feedback perceptions aligned (Carless, 2006; Carless, 2013). Other studies focused on what students define as "effective feedback" (De Laet et al., 2016; Tinto, 1993; Sheppard et al., 2009). Despite substantial literature on feedback perceptions, there is a gap in how feedback perceptions are conceptualized: very few studies provide explicit definitions of feedback perceptions.

Understanding how students perceive feedback can facilitate designing such feedback practices and interventions that would be beneficial in terms of improving learning and achieving academic success.

2.2.2. Feedback perceptions in large classes in engineering

Following the feedback perceptions' definition by De Kleij et al. (2013), every learner has very unique feedback perceptions based on multiple aspects, including internal factors: student's prior experience in feedback, perception of what constitutes positive and negative feedback; and external factors: such as learning environment, and interactions with fellow students, instructors, teaching assistants, friends and even roommates.

Taking into account a learning environment such as engineering, large classes might be a very important issue (Kara et al., 2021). Knowledge in engineering education is strongly scaffolded (Sheppard et al., 2009; Ohland et al., 2008; van den Bogaard, 2015) and on average, students in engineering spend more hours studying compared to students in non-STEM field (Hornsby & Osman, 2014). Therefore, it is essential for students to receive feedback that helps them to evaluate whether they have mastered new skills.

Many studies show that due to the increasing class size, there is a wider variety of students' prior education, cultural backgrounds, age, gender and other personal attributes (Mulryan-Kyne, 2010; Biggs, 1999), however, it is not necessarily true for every large class. Literature suggests that large classes limit possibilities for students to receive high-quality targeted feedback from a teacher (Mulryan-Kyne, 2010; Robinson & Cooper, 2000; Bandiera et al., 2010). Teachers are unable to devote enough time to every student due to the class size, which according to leads to anonymity, passivity, poor engagement with course content and low motivation amongst students. Students are less willing to seek help (Robinson & Cooper, 2000).

2.2.3. Social interactions in large classes

Another important aspect that according to the definition by De Kleij et al. (2013), impacts students' feedback perceptions are social interactions. This is supported by Mulryan-Kyne (2010) and Feldman (1984) who state that interactions between students and teacher are essential to let students feel comfortable in the learning environment. Authors (Mulryan-Kyne, 2010; Feldman, 1984; Hoyt & Lee, 2002; Hodgson et al., 2010) suggest that as a class size increases, ratings of the course and the instructor declined slightly, and ratings of interactions and relationships between teachers and students declined dramatically.

However, difficulties in interactions between teachers and students is not caused by the context of a large class only. Another important aspect that influences students' engagement with the course and motivation is their experience of a new learning environment (Tinto, 1993).

2.2.4. Overall experience of a new learning environment

According to Hodgson, Lam & Chow (2010), the transition from secondary to higher education is a crucial period for students. During transition time students need to prepare for university and to acquire certain skills for their future careers. During their studies at university, students should be able to develop confidence, and become autonomous and

sophisticated learners (De Laet et al., 2016; Bangser, 2008). Feedback is instrumental to support this entire process of transition and for all students to reach the required levels of knowledge and skills (Hattie & Timpereley, 2007). Additionally, research indicates that how students feel in their learning environment play a significant role in how instructional feedback is perceived (Hattie & Timperley, 2007; Lipnevich & Smith, 2009; van der Kleij et al., 2013). Studies suggest that when students feel confident, safe and supported in a new learning environment, they are more likely to perceive instructional feedback constructively. Conversely, negative emotions and experience of the learning environment leads to a defensive response when students reject or dismiss feedback.

2.3. Method

2.3.1. Collecting data on feedback perceptions

The data was collected from undergraduate students of Computer Science program during their first semester. The aim was to explore what feedback perceptions first-year bachelor students have. Therefore, the main research question was as follows:

RQ1. How do first-year bachelor students perceive feedback?

Our focus was on first-year bachelor students, because the transition from secondary to higher education is a time when a lot of high-potential students drop out if they do not manage to make the transition successfully (De Laet et al., 2016; Bangser, 2008).

We administered semi-structured group interviews with 17 undergraduates during their first semester: 4 females and 13 males with different educational and cultural backgrounds and age. Interviews were held in the beginning, in the middle and at the end of the first semester. This way we captured the full experience as students started their coursework, progressed and prepared for their first exams. Although we touched on the same topics in every interview, the guide was adjusted to reflect on their progression in the coursework (see Appendix A).

In total, 19 group interviews took place: 11 group interviews in the beginning of the first semester; 6 group interviews in middle; 2 group interviews in the end of the first semester. All students participated in the interviews voluntarily. Interviews were organized during lunch breaks so they would not interfere with classwork. All participants were offered free lunch during the interviews.

This study was approved by the TU Delft Human Research Committee. The researchers in the team had no responsibilities in the Computer Science program under study nor do they have any formal relation with the Computer Science program.

2.3.2. Instrument

Since the concept of understanding students' perceptions of feedback is not new, many researchers and educators have tried to collect data on what students want in terms of feedback (Winstone, 2017; Harks et al., 2014). For that purpose, standardized evaluation questionnaires are used often. These instruments tend to measure frequency, quality and amount of feedback provided for a specific course or a particular moment of time; while learning process itself is often overlooked (Krueger, 1994). As a result, such evaluative questionnaires represent attributes of the quality of a learning environment, but not necessarily the quality of learning that has taken place. For our study we chose semi-structured group interviews instead. We believe that exactly engaging into a conversation with students, helps us to create a better understanding on their feedback perceptions. Therefore, this approach is unique, and provides with a deeper understanding of what students actually mean when they try to define feedback, its purpose, usefulness and application.

Group interviews provide participants enough time and options to discuss their experiences and share their visions with each other (Cohen, Manion & Morrison, 2011; Creswell, 2007). According to Krueger (1994:255): "…group interviews can capture the dynamic nature of group interactions and create social contexts that are more natural to respondents that

individual interviews". The aim of the interviews was to explore students' perceptions of feedback within a large class setting. Interview questions were therefore divided into three topics that are directly related to feedback perceptions and finished with a broader question to explore the context as a whole:

1. **Large class:** how do students feel in their new learning environment; what do they consider positive and negative aspects of a large group; how to they feel in a large class and whether their feelings change overtime; students' ability and inability to ask help; Feedback: what students think feedback is; their understanding of "negative" and "positive" feedback; whether they use feedback for learning and how; students' experience of feedback which was opposite to their expectations;
2. **Social interactions regarding feedback:** interactions with lecturers; interactions with fellow students or peers; help and support from Teaching Assistants; interactions with friends or house mates; students' strategies to overcome difficulties in learning– if any;
3. **Overall experience of studying in a new learning environment:** for this research, it was important for us to give students a possibility to tell us how they experience their new learning environment: what they liked about it and what were they missing; challenges and difficulties that students faced; strategies they find useful; students' definition of a successful student; students' comments and suggestions to educators.

2.3.3. Research design

Since the main purpose is to focus on what students see as feedback and how is it perceived by individuals and by the group in general, the researchers chose a phenomenological approach for this study. Phenomenology allows the researcher describe "…what all individuals have in common as they experience a 'phenomenon'" (Park, 2000). In this case, group interviews allowed us to get insight in lived experiences right at the time of collecting data. However, this is also one of the disadvantages of group interviews. According to Park (2000), the phenomenon of 'group think' can occur – people in a group tend to agree with

each other even if they initially reported different experiences and thoughts (Gubrium & Holstein, 1997, 1998; Fusch et al., 2022). To lower the chance of group think occurring, we decided to do semi-structured interviews – removing strict structure of the process gave the researcher an ability to interact with individuals while limiting interference with the group dynamic.

2.3.4. Analysis

All interviews were transcribed verbatim and were analysed as a single data set. To maintain reliability of this study, the research team and an external researcher, familiar with data analysis, were involved in checking and recognizing codes.

The qualitative analysis software package ATLAS.Ti was used to analyse the transcripts. All identifying information was removed from the transcripts.

The first round of analysis and coding was done by the first author of this paper. As suggested by Miles & Huberman (1994), the researcher began with four overarching, generic codes, derived from the literature review, and continued exploring the data with more detailed codes that were created as analysis progressed. The entire process of coding and analysis was monitored and checked by other members of the research team – the second author of this study. After that, Author 1 engaged into in vivo coding. Preferably, each fragment would have a single code only, however, some fragments have references that apply to multiple codes and were therefore assigned multiple codes.

2.4. Findings

We present the findings below, clustering results under the broad codes we used for initial coding. During each interview we had various number of students participating, from 3 students to 7 students per group. To report our findings, we use such generalizing terms as ‘a majority’ or ‘most students’, these terms indicate that more than a half of the group

participating in the interview agree or disagree on certain statement or question stated by the interviewer.

2.4.1. Large class

Students were asked to reflect on their transition from secondary school to university in terms of class size, specifically about their feelings, emotions and perceptions of the large group they are part of. We identified three perspectives:

1. Large class as an advantage: several students state that they feel comfortable and positive in a large class. In their opinion, large class provided them with a lot of possibility to mingle with their new class mates, find people with common interests, feel motivated by others, find new friends: "…a lot of people, a lot of minds... you can always get to know new people." Some of these students are surprised that the class atmosphere is friendly.

Students also like the fact that due to such large numbers of students attending the lecture, the teacher rarely puts attention to the ones who leave the class or are doing other things, like playing games on their phones or chatting with their friends. For those students, anonymity in large class is definitely an advantage. Students say the particular phrase: "…You are not being watched..." quite often during the interview.

One student has decided to skip certain lectures and has done it during the entire semester. On the question why? He says that he gets the same feeling of just watching a recorded lecture if he sits at the back. He thinks studying in a large class is an advantage: "...if I don't show up, they don't care, or if I am not there, I will not be missed...I think that's great..."
Two female students state that the biggest benefit of a large class is that it provides you with independence, autonomy in your own learning: "…you are treated like an adult – given responsibility and independence…". Next to that, they think that in a big group someone might ask questions that you [students themselves] are not aware of, which is also considered a benefit of a large class according to some of students.

2. Large class: neutral attitude. Few students claim they felt nothing in relation to a large class. Two of them started their bachelor program for the second time, therefore have already experienced studying in a large group. Previously, these two students attended a different university and a different Computer Science program, however, they both had experience studying in large groups. Other interview participants could not specify any special feelings or emotions to the fact that they are studying together with other 500 new people.

When prompted they struggled finding advantages and disadvantages of studying in a large class, stating they never thought about it before. There were a lot of doubts amongst those students about how they feel in a large class. Common phrases were: "…I don't care", "…I don't know…" and "…I guess…".

3. Large class as a disadvantage: the majority of students consider studying in a large group a big disadvantage. Mostly female students experience negative attitude towards large classes. They interpret teacher's behaviour as follows: "…in the lectures it's like they [teachers] don't want you to ask questions…". Another negative aspect of a large class is that due to the fact that Delft University of Technology is not prepared to host all 500+ students in one auditorium, all lectures take place in the Conference Centre – the largest auditorium on campus. Since this specific place is not designed for lectures, students face difficulties adapting to this learning environment. A lot of negative comments are about physical attributes of the auditorium, such as, for example, lack of tables or surfaces to write on, lack of appropriate lightning. Students conclude that all those characteristics make it more difficult to focus: "….so it kind of makes you more prone to zone out…". Most students mention that large classes make them feel intimidated by their size: feeling invisible, feeling lonely, feeling stupid, feeling scared – those feelings are mentioned most of the time. Mostly female students describe strong fears related to large class: "I feel scared because I think that they [teacher and other students] would think that I am stupid...or I am not up to date or something..." or: "It's just like...500 people are staring at you, like, what is she asking...that kind of feeling just

scares me - so I do not dare to ask questions…". Following statement is repeated very often through the entire study by multiple students: "I just don't want to disrupt the lecture…". Students state they do not really ask questions, even if something stays unclear.

When the interviewer met students for second and third time, some more information was shared via interviews. Mostly, students mention feeling unseen in the large class and: "…just a part of something huge…". Some of the students mention that they got used to the amount of people in the class. Others mention that with time, fewer students come to lectures. Several students expect fewer students to complete their BSA (minimum number of credits necessary to enrol in the second year of study, for Delft University of Technology it is minimum of 45 out of 60 credits by the end of the year).

As the semester progresses the majority of students conclude that atmosphere in the classroom depends on number of students attending the lecture. They suggest that when they study in smaller groups, they [students] have more appropriate atmosphere for learning since it is less distracting.

A majority of students mention that contrary to the Conference Centre, smaller groups are often placed in different classrooms which have all the facilities that students require, such as tables, appropriate lighting, chairs. A major difference in class atmosphere that students mention as the semester progresses, is that everybody made more friends.

2.4.2 Feedback

The students' perceptions about what feedback is, can be divided into two categories: feedback perceptions and feedback purpose.

Feedback perceptions

In terms of Feedback perceptions, students mostly use such words as: information, opinion, advice.

Talking about perceptions, students mostly base their understanding of feedback on previous experiences, which, in most of the cases, means secondary school learning environment. In this case, their feedback perceptions are closely connected with how their relationships with secondary school teacher were. Students mentioned that their relationships with secondary school teachers played a big role in how they [students] perceived feedback. According to students, when having good relationships with a teacher, a student would most likely see feedback as 'fair'. And on the contrary – when relationships with teacher were not so good, a student would most likely ignore feedback and think it is 'not fair': "….it depends how feedback is given...because if someone is, like, all negative about what I did and not constructed – I just ignore him. Yeah, I would not care about it…". Since students have little to none experience with feedback at university, they mostly talk about what they expect feedback to be, what they think is useful feedback. According to their expectations, useful feedback contains detailed examples. An important note here from the students is that those examples should be the same difficulty level as the ones that appear to be on exam. Several students state they require more step-by-step guidance.

a) Feedback purpose

Some of students describe feedback based on its purpose. Most commonly used words in this case are: improvement, suggestion, evaluation, help, critics, learning as a purpose of feedback was mentioned by only 1 student.

Few students struggled formulating their understanding of feedback and could not answer the question, however they stated that feedback can be positive [3 students] and negative [3 students].

An interesting conclusion emerged from the way how students formulated their understanding of feedback – none of the students assumed that feedback can be generated

internally; all students assumed that feedback is per se provided by a teacher or someone else: “External help, external evaluation.”; “Usually comes in the form of suggestion or advice”; “…to give me advice for things I do wrong or right.”

Since all participants are first-year bachelor students in their first semester, most of their experience with feedback comes from secondary school. In their discussions about feedback, students move back and forth from secondary school to university, comparing these two learning environments in terms of feedback they receive.

Most students say they use feedback that is provided to them; few students tend to ignore feedback, as far as they get a ‘pass’. On a question why [do students ignore it], they say that feedback that they receive in secondary school is mostly grades, which in their opinion have little value.

When asked about what do they do with feedback they receive, most students would first focus on “negative” feedback. By “negative” feedback students suggest comments from teacher [university] or teaching assistants [university] that can be harsh, mentioning flaws in students’ work, offending students’ feelings. In general, students would find this feedback less pleasant, however, the most efficient for learning: “…it aims towards improving stuff and usually is not always good, and some people get offended by it, although it's purely constructive feedback, I mean, you should learn from it, not take offense at it…”

However, as mentioned by few students, they would not want to receive only feedback which is constructive. From their words, “negative” feedback only is no use because it only shows what is done wrong, but doesn’t give them a chance to discover how to do it right.
When asked about “positive” feedback and its application for learning, several students say that they [students] see it as an indicator that they are on the right track. Only few of students would ask for more feedback or extra study.

In general, students had quite positive attitude towards feedback, seeing it as something that helps them improve. However, when asked to provide an example of how do students actually apply it for their learning at university, most of students hesitated to answer or could not answer at all. According to students, most of the time feedback consists of grades which indicate how well you know the material – at the same time makes it difficult to improve, since it only shows the flaws. That conflicts with students' statements that they use feedback provided to them.

b) Interactions

In terms of interactions, university and secondary school were discussed as two distinct learning environments. Both experiences were compared in terms of teacher – student and student – student interactions.

Based on comparisons between the two, there were five main actors identified in terms of interactions: fellow students; teacher (university); teaching assistants (university); friends and roommates; teacher (secondary school). Most of the interviewed students had experience interacting with all five actors.

When talking about teacher – student communications, many students concluded that there is certainly less personal connection at the university. However, students see it as an attribute of a large class. Some students say: "Well, yeah, like I said earlier, like, less personal. Like it is more, like, big group – I[teacher] do not know any of you, but I[teacher] just…talk...";
or the following statement: "I feel like...interaction between the professor and students is obviously less here."

Majority of students state that they miss more personal connections with their teacher, by giving examples of how it was at their secondary school and comparing it to the situation at the university: "We had small classes of 24 students each approximately. And the advantage of that was that the teacher was very, like, focused on issues. Right. They knew the strengths

and weaknesses of each student. They could help them and catered them to their needs. Now it is more independent...the professor does this thing, and if you get it, you get it. He cannot, kind of, help you out, as much as there are 500 of us, of course. So that's my only problem. I feel like now it's not so focused…"

Some students agree that having a less personal connection with the teacher makes it difficult to seek help or ask questions: "…if I feel that I have more personal connection [with a teacher], then I can easily ask them what is on my mind...and with that, I am too scared at the moment to even get close to the teacher."

When asked about what kind of interactions the students expect, many answers were similar to the following: "… [in secondary school] we would get feedback on things like – how you should approach the problem, which is what I was kind of missing out [at university]. … Now I kind of try to figure out the way or sort of approach [for] the problem, which I am not really getting that right now. I want to be able to distinguish between ...this problem - I know I have to do this and this, but right now I am in the grey zone…".

A lot of students say there is a clear difference between teachers in secondary school and teachers at university. According to students, you can only approach teacher during the lecture or in between the break. Several students tried to approach teachers after lectures but did not succeed: "I mean you do not really see the teacher outside the lecture...so it is like... they vanish…"; "I mean, you could probably go talk to them[teachers] if you know where they are...but you don't know where they are…".

In the beginning of semester, teaching assistants are students' main source of feedback, answers, help on any matter. Students claim that in contrast with university teachers, teaching assistants are easier to approach in case of a difficulty: "The TA [teaching assistant] represents the lecture more than the teacher because the TA is someone who is slightly older than you[student] and he has slightly more experience so he knows what you are going

through and what you need and what you don't understand, and lecturer is just someone who is some guy or some woman who knows a lot about it and just tell you all the material…". At the same time, students argue about advantages and disadvantages of having teaching assistants: some students say that several courses need way more teaching assistants that they have at the moment; others argue that number of teaching assistants is fine, but their level of competence is actually lower than students hoped for.

All students agreed on the fact that although teaching assistants are very helpful and easy to approach, the biggest disadvantage is that they are very busy and quite often not competent in the area that students need help in. Some students give explicit examples: "…so I had a question and he [teaching assistant] was not able to answer it so he had to forward it and it took a long time. So, I did not want to ask questions to TAs because it took them too long to answer...so I asked my questions at 2 p.m. and I got an answer at around half 3.30 p.m. or something...like...then I would sit there for two hours doing nothing...".
Another example illustrates two opposite experiences that students got when asked teaching assistant to help:
Student 1: "…they [teaching assistants] always try to explain it on a conceptual level...and I get it - you want people to get it on conceptual level...but if you are explaining JAVA programming , you cannot do anything on a conceptual level...and he was talking like...stuff and I never heard of it...and how am I going to implement it if I do not even know what you are writing...at least...so...he could have just said how it was done...and then no need to describe it....".

Student 2: "…they [teaching assistants] give you less guidance – like step by step what to do, and because of that – when I am stuck and I want to call a teaching assistant, I do not know what to ask…like, what is the next step? But then they are just going to do an assignment for me…and you sit there, like – am I doing this right...and they are, like – yeah, looks good, and you are like – cool...what exactly?".

All interviewed students used help of teaching assistants at least once. However, only few of students continued to do so as the semester progressed.

From the interviews it was clear that as students' progress through their studies and make more friends, they tend to ask help from friends rather than teachers or TAs. Some students also mention free online resources, like field-related forums, where they can ask questions.

c) Overall experience

All of the students had many comments, suggestions or complaints. Foreign students experienced homesickness, and feeling alone. The majority of students felt overwhelmed with the study load, the pace of the lectures, and the number of students in the class. According to the students, feeling overwhelmed comes from a lack of guidance, and a lack of clarity on how to prioritize or plan certain study activities: "we are overwhelmed, we got assembly, tests, we got peer feedback for which we need to do exercises from the book, we review each other exercises, we also have to read each other's exams... so we have this stuff to do and sometimes it's not obvious where we should be doing that peer feedback, or the assignments and stuff like that, because for peer feedback there is only one deadline, which is at the end of the term...so...I kind of skip this part and focus on straight feedback...I never know exactly where should I focus on...". Other students agree: "I kind of find it difficult with time-management."; and: "Sometimes I feel a little bit overwhelmed...every time they [teachers] ask us to do anything I need help prioritizing what we should get done…"

The majority of students concluded that they have difficulties with planning, prioritizing, sticking to the schedule and keeping on track. Those difficulties impact students' mental wellbeing and result in feeling overwhelmed and stressed. Students who do plan their studies, tend to give up their schedules when they face difficulties completing them.

Students reflected on their own motivation, which would be almost entirely external. One student says: "I knew I would not aim high as before but I did not know I would just literally

be aiming to pass...and then I am, like, happy with it." Another one explains what motivates her: "Whenever I would get a good grade it would also motivate me. Because of the fact that it was good would motivate me that what I did was worth it". Sometimes, motivation came from unexpected sources: "…so far, my only motivation is like searching Computer Science job and there is a lot of money, yeah, seriously that is like really high wage...so that is my only motivation...I don't know if it is good or bad".

2.4. Discussion and conclusion

2.5.1. Discussion

The aim of this study was to explore how first-year bachelor students perceive feedback. In total, 17 students participated in semi-structured group interviews which took place during the first semester. There were 4 females and 13 males interviewed. All students were in the beginning of their study of program of Computer Science at Delft University of Technology. All students who participated in the interviews study in the same class of little over 500 people.

We started with what students understand as feedback, and tried to explore some of the aspects that may influence those understandings. During the interviews, several topics related to feedback were discussed with students. Specifically: large class learning environment; feedback; interactions; and overall experience. Students gave their explicit opinions on each of the topics and shared their experiences with each other and the interviewer. Preliminary findings show that the majority of students see large class as a disadvantage. Such feelings as feeling unseen, anxious, scared, or anonymous were attributed to the large class learning environment by most of the students. Both Biggs (1999) and Mulryan-Kyne (2010) state that large classes result in passivity and lack of motivation amongst students. During the interviews, majority of students complained about having difficulty finding motivation to study. Several sources of motivation they specified were:

1. passing the course for the sake of 'passing';
2. receiving a good grade;

3. exploring future possible salaries in the field.

However, according to other students, the lack of motivation is the result of study load and level of difficulty of the course, and not a large class as a learning environment. Several students mention that they do experience difficulty focusing on lectures and sometimes lose their focus. Following the interviews, this behaviour is linked to the physical attributes of the classroom, such as lack of tables, poor lighting and uncomfortable chairs. In some cases, women seemed to bring forward different answers that their male colleagues and in the next phase of the analysis the researcher wants to take a closer look at this. Women mentioned that large number of fellow students makes it hard to ask questions. They experience fear of looking stupid in front of other 500 people. Male students did not express any concerns about this matter for some reason. However, the men admitted that they experience a very wide variety of prior knowledge in the classroom, and explained their reason of not asking questions: since the pace of the lecture is very high and stable, students do not want to disrupt the flow, even if they do not understand something.

Talking about feedback, the preliminary results showed that students know and understand the importance of feedback in terms of improving their own learning, however they rarely actually use it as such. Students were asked whether they use feedback that they receive. Most of the times students would answer that they do use feedback that they receive. Next, the interviewer asked to give an example of how do students use feedback for their learning. Majority of students could not give an example. They argued that the only feedback they receive is grades, therefore they could not answer this question. This situation created a feeling that either students did not understand a question, or did not understand what 'using feedback for learning' means.

In their discussions about feedback, students relied strongly on their previous experience with feedback: secondary school. Students attempted to reflect on their previous experience with feedback in secondary school and drew the conclusion that depending on

their relationships with a teacher they would actually consider feedback 'fair' or 'not fair'. Students specify that having good relationships with a teacher can result seeing feedback as 'fair', while having bad relationships with a teacher result in seeing feedback provided by the same teacher as 'not fair'. Those conclusions alight with feedback perceptions definition by De Kleij et al. (2013), who states that feedback perceptions can be influenced by certain aspects, and characteristics of a feedback provider is one of them.

According to several studies (Feldman, 1984; Hoyt & Lee, 2002; Hodgson et al., 2010), as a class size increases, students lose personal connections with the teacher. From the interviews with students, we see that there is certainly less of a personal connection between students and teacher. The majority of students stated that they miss more personal connections with teachers like they had with their secondary school teachers. However, they suggested it might not be possible at university. Students themselves name several reasons for that:

1. Class size: all students who were interviewed agreed on a fact that large class makes it difficult for teacher to have interaction with students. They argue that some teachers try to make lectures more interactive, however, students' role in those interactions is mostly passive.
2. Time constraints. Students specify that the pace of the lectures is usually very high, meaning there is less room for questions, dialogues or communication. One student reflects: "…they [teachers] try to make it [communication] two-sided, but it is mostly one-sided…". A majority of students agrees that since there is a large amount of information to be transferred by means of lectures, teachers simply do not have time for other activities.
3. Teachers' perceptions. Most of the students have their own perceptions about university teachers. All interviewees tried to compare their secondary school teachers to university teachers. Students concluded that at the university level teachers' main goal is to transfer knowledge, therefore no student expected to have similar relationships with teachers as they had in secondary school. Students concluded that

there is a distance between teacher and students. For several interviewees this distance is so intimidating that they would not even come close to a teacher physically.

From the analysis of the interviews, students reported that having personal connections with a teacher helps students to feel more comfortable in the class to ask questions or seek help.

Teaching assistants are considered easier to approach. All of the interviewed students, in one way of another, interacted with teaching assistants. Although most of the time students had good experiences with teaching assistants, there were several complaints. According to the students, most of the time teaching assistants either do not know how to help or do not do it properly, as expected by a student, namely:

1. Teaching assistants take too much time answering students' questions
2. Teaching assistants tend to do assignments for the students instead of guiding them through

From students' perspective, teaching assistants tend to offer complex conceptual explanations when unnecessary. According to students, fellow students and internet are most popular sources to get help, answer to a question or solution to a problem.

Several studies (De Laet et al., 2016; Bangser, 2008) show the importance of students, transitioning from secondary school to university, to receive high-quality continuous feedback. According to the studies, this process will help students to become independent learners. All the students who were interviewed had troubles planning their study activities and sticking to the plan. In addition, majority of students experienced difficulties prioritizing assignments. Students themselves attribute these challenges to feeling overwhelmed. According to them, there are several reasons to have this feeling:

1. Pressure of the study load
2. Complexity of the program
3. High pace of the lectures
4. Large number of students in the class

5. Feeling homesick
6. Lack of guidance from teaching staff

Especially the lack of guidance received a lot of students' attention. The students had many suggestions, advice and very specific details on what exactly they need from teachers and teaching assistants.

In addition, students reflected on their own ways to get motivated to continue their studies. According to the students, the main aspects of motivation are good grades, passing the course and high salaries in Computer Science field. Some students engaged in self-reflection and were surprised with how in reality they just agree on a 'pass', while they [students] expected to strike for a higher grade before.

2.5.2. Limitations

A number of following factors limit generalizability of results of this study: this study included a relatively small number of students from a specific program in a single institution in the Netherlands. Participation was voluntary and, as the study progressed, a lot of students stopped responding to our invitations for group interviews. We intentionally tried to sample for a maximum variation in student backgrounds, yet we are unsure if we managed to retain this diversity in later interviews.

2.5.3. Future directions

For the next round of analysis, there are several aims to reach:

1. There were several situations during interview where the women gave distinctly different answers than the men, therefore more research is needed to take a closer look at that matter. The numbers are small, yet it is still important to check for potential patterns.
2. The entire data collected was analysed as a single dataset, yet there were three rounds of interviews with notable periods of time in between – 4-6 weeks in between each round. It is important to see if there are significant changes that influence students' perceptions overtime.

This study shows importance of understanding feedback perceptions in general by providing a new perspective for feedback in higher education. Preliminary findings that are discussed in this study are indicative of the importance of feedback perceptions, however, more study would be beneficial. Future research should also study how feedback perceptions change over time as students' progress in their learning. As with much of qualitative research, the results here depend almost entirely on the research team, approach to analyse the data, a moment of data collection and instrument which was chosen to collect data. It is paramount that future studies include quantitative approaches to triangulate the results of studies like ours.

2.5.4. Conclusions

We established that feedback perceptions provide us with a new viewpoint to feedback and that it is useful for the field to continue to study this.

Chapter 3. Feedback in large Computer Science classes

Exploring students' instructional feedback perceptions and association with students' learning strategies

This chapter has been accepted for publishing in the European Journal of Engineering Education in adapted form as:
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3.1. Introduction

The goal of instructional feedback is to help students identify gaps in their knowledge and to provide adequate information on how to close those gaps (Carless & Boud, 2018). However, Ajjawi and Boud (2016) found that instructional feedback does not always result in improved learning and Carless et al. (2017) observed that not all students apply the feedback they receive to improve their learning. In fact, Van der Kleij (2019) found students often ignore instructional feedback, they do not notice instructional feedback, do not understand feedback, or do not have opportunity or willingness to use it. Students' individualistic attitudes and beliefs about feedback, instructors, learning environment, and students' mental and physical state in the moment of receiving feedback, have been identified to influence how students perceive instructional feedback (Chong, 2020; Carless & Boud, 2018, Sutton, 2012). Van der Kleij et al. (2015) labelled these aspects of student responses to feedback perceptions. Shute (2008) and Van der Kleij (2019) established that students' individual feedback perceptions account for the large variability in the impact of instructional feedback on students' learning. However, it is unclear what the impact of feedback perceptions is, and for how much variance it accounts. It is clear, however, that individual perceptions of instructional feedback vary within groups of students, even if they are in the same course, and feedback perceptions are highly individual (Van der Kleij 2019). Several researchers established that while instructors see their feedback as useful, students claim to not perceive it as such, and consequently, do not use the feedback they receive (Hargreaves, 2012; Havnes et al., 2012; Voerman et al., 2014). Bjork et al. (2013) found that students believe they know how to study effectively, yet they often engage in learning by using ineffective learning strategies. This is problematic as much research is based on the idea that positive students' perceptions of instructional feedback are associated with the use effective learning strategies (Jonsson, 2013; Jonsson & Panadero, 2018). However, the associations between students' perceptions of instructional feedback and students' use of effective learning strategies are not clear and the lack of understanding of these relationships creates challenges for designing more effective feedback systems and

providing students with more impactful feedback. This is especially important for courses with large enrolment where it is very challenging for instructors to forge personal relationships with their students (Kara et al., 2021; Mulryan-Kyne, 2010; Bandiera et al., 2010). Our study is set in the context of Computer Science, a field which has seen a tremendous growth in student enrolment in recent years. Transition into higher education is a challenge for many students, and when students land in programs with large courses without much personal attention from their instructors, they will have to rely on the feedback they receive, and learn how to apply it in a high-paced, high-stakes learning environment (Hodgson et al., 2010; Bangser, 2008; Sheppard, Macatangay, Colby & Sullivan, 2009).

To address this gap, this paper explores the relationship between how students perceive instructional feedback, students' motivation, and what learning strategies the students commonly use. This study is guided by the following research question: What are the associations between feedback perceptions, learning strategies and motivation amongst first-year students of Computer Science?

By addressing this question, we advance the understanding of how feedback perceptions impact students' motivation and their use of learning strategies. We consider this key to promote learning strategies that are effective for students in the long run. In this paper we will address: 1) students' reported perceptions of instructional feedback; 2) students' reported motivation and learning strategies; and 3) associations between students' feedback perceptions and students' motivation and commonly used learning strategies.

3.2. Theoretical framework

3.2.1. Defining feedback

Feedback as a term means different things to different people, which is partly due to the variety of feedback perceptions people have (Carless & Boud, 2018). Amongst feedback scholars, feedback is commonly divided in formative and summative feedback, based on

unique purposes of each (Bloom, Hastings & Madaus, 1971). Narciss and Zumbach (2023) describe formative feedback as a diagnostic tool to provide information to student in the process of learning when corrective adjustments are still possible, while summative feedback aims to assess student's knowledge against the reliable criteria for the purpose of certification. Sadler (1989) calls for an explicit separation of formative assessment from grading or certification, as information that might be added to a grade is often perceived as an explanation of the grade rather than feedback that needs to be considered to improve learning. Students, who are the ultimate receivers of instructional feedback, are often unfamiliar with different types and purposes of feedback. This makes it challenging for students to recognize, make sense of instructional feedback and use it effectively (Carless & Boud, 2018, Panadero & Lipnevich, 2022; Leenknecht & Carless, 2023).

In this paper we position feedback within the definition of Henderson et al. (2019:268): 'feedback is all the processes where the learner makes sense of performance-relevant information to promote their learning'. Following this definition, feedback might come from instructor, peers, it might be generated by a learner, a computer or a task itself. Feedback might include information to reflect on where the learner is, where the learner is expected to be, and what actions should be taken to get there.

3.2.2. Emerging concept of feedback perceptions

Feedback has long been conceptualised as a linear process: when feedback is provided by an instructor, students will apply it by reflecting on their understanding of the content and on their learning strategies (Winstone et al., 2017). Students were considered to have a passive role, hence experts focused mostly on guidelines for instructors to craft effective feedback. It was believed that since feedback is linear, the outcomes of providing one or another type of feedback are predictable: students need to be told what to improve and how to improve which ultimately results in students' improved learning and performance (Torrance, 2012). However, as more research on feedback emerged, the conceptualization of feedback as a linear process became the subject of dispute. Sadler (1989), and Hattie and

Timperley (2007) conceptualise feedback as a complex process in which students play a critical part: feedback has a powerful impact on students' learning only when the learner uses the feedback information and takes the appropriate actions. However, the extent to which students take appropriate action varies largely, meaning that 'acting upon instructional feedback' means different things to different students (Handley, Price & Millar, 2011). Scholars found that every student has a unique perspective on instructional feedback, and every student has individual agency in deciding whether or not to act upon instructional feedback, and how to engage with it (Lipnevich et al., 2016; Handley, Price & Millar, 2011; Gravett, 2020; Chong, 2020). This idea laid the foundation for the concept of feedback perceptions. Van der Kleij et al. (2013) defined feedback perceptions as: "… concerned with how a learner perceives feedback, which is assumed to be influenced by the feedback message, characteristics of the feedback provider and the frame of reference of the feedback receiver" (p.1014). This includes the full gambit of aspects of a learning environment, ranging from how a learner experiences interaction with instructors and peers, the physical environment, the quality and availability of materials and information, et cetera. Van der Kleij & Lipnevich (2020) postulate that this variety in aspects that influence how students perceive feedback results in a large variety of possible subsequent actions (or lack thereof) amongst students. Possible subsequent actions pertain to students' (meta)cognitive and behavioural responses, and positive feedback perceptions do not always result in effective use of the feedback and ultimately in improved learning (Black & Wiliam, 1998; Chong, 2020; Van der Kleij & Lipnevich, 2020).

3.2.3. Students' motivation as a precursor to students' perceptions of feedback

Harks et al. (2013) claim that the process of engaging with feedback starts with students' perceptions and leads to students' instructional feedback interpretations and "actual use of feedback" (Harks et al., 2013, p. 273). However, Handley et al. (2011) argue that the process of engaging with feedback calls for an explicit distinction between students' "readiness to engage with feedback and active engagement with the feedback" (Handley et al., 2011, p.549). Handley et al. (2011) and Chong (2020) define students' readiness to engage with

feedback as a particular mindset that includes aspects as noticing feedback, willingness to accept instructional feedback, and perceiving feedback as useful (see also Carless & Boud, 2018; Carless, 2006; Handley et al., 2011; Nicol & Macfarlane-Dick, 2006, Leenknecht & Carless, 2023). Noticing feedback and the willingness to accept and use it is a necessary condition for students to perceive feedback as useful. When instructional feedback is perceived as useful, students tend to engage with feedback actively. Students' 'active engagement' means (1) students are willing to accept instructional feedback, make sense of it and use it; and (2) students can create an action plan to use instructional feedback effectively (Carless & Boud, 2018; Handley et al., 2011, Panadero & Lipnevich, 2022, Strijbos et al., 2021).

Studies have shown that students' motivation, such as self-efficacy and intrinsic factors, play an essential role in determining what kind of mindset students have towards receiving instructional feedback (Gravett, 2020; Shute, 2008; Kluger & DeNisi, 1996).

Self-efficacy relates to how confident students are in their ability to accomplish the tasks successfully, which in turn is influenced by previous experiences with instructional feedback (Lipnevich & Smith, 2009; Bandura, 1997). Intrinsic factors include e.g., students' personal values, interests and learning goals (Chong, 2020; Pintrich & DeGroot, 1990; Lea & Street, 2006). Harks et al. (2014), found students with high levels of self-efficacy and intrinsic motivation are more willing to accept instructional feedback and use it appropriately.

3.2.4. 'Active engagement' with instructional feedback

As mentioned by Handley et al. (2011), students' 'active engagement' starts when students perceive feedback as useful and can plan subsequent actions to improve learning. However, even positive perceptions of instructional feedback do not guarantee improved learning (Cervin-Ellqvist et al., 2020; Bjork et al., 2013). One of the key conditions to improved learning is that students possess effective learning strategies to utilize instructional feedback (Jonsson & Panadero, 2018). According to Bjork et al. (2013), Pressley et al. (1989), and

Dunlosky and Rawson (2013) students often engage in ineffective learning strategies without realizing it. To establish which learning strategies actually contribute to students' learning, Gurung (2005), Hartwig and Dunlosky (2012) and Dunlosky et al. (2013) evaluated the relative utility of several learning strategies in multiple different academic fields (Smith et al., 2010; Schworm & Renkl, 2006; Wong et al., 2002; Bednall & Kehoe, 2011; McDaniel et al., 2012; Cashen & Leicht, 1970; Levin et al., 1979; Leutner et al., 2009; Carrier, 2003; Bude et al., 2011).

Some strategies used in the evaluation, such as rereading or highlighting, were reported to be heavily used by students, while other strategies, such as spaced practice and practice testing were not used much by students (Gurung, 2005). Dunlosky & Rawson (2013) developed a framework of evaluated learning strategies and their relative effectiveness for student learning. The common learning strategies that Dunlosky and Rawson studied are presented in Table 1. The 'low' effectiveness learning strategies can be beneficial for students in the beginning of their studies, such as for example re-reading and summarizing, yet Dunlosky and Rawson (2013) and Hartwig and Dunlosky (2012) established that these learning strategies tend not to be advantageous for student learning as they progress in their studies. There is a certain level of ambiguity to what students do exactly when they use certain learning strategies and to the reasons behind using learning strategies, yet students perceive certain learning strategies as effective enough to continue to use them, even if the strategies may not lead to improved learning.

Table 2.1.

Learning Strategies and their utility level

Learning strategy	Description	Strategy effectiveness
Practice testing	Self-testing or practicing testing over material that is to be learnt	HIGH
Spaced practice	Scheduled spread study activities over time	HIGH
Elaborative interrogation	Understanding the concept by creating an explicit explanation for it	MODERATE
Self-explanation	Creating a link from new material to the existing knowledge	MODERATE
Interleaved practice	Practicing solving different problems, or studying different kind of material in singe session	MODERATE
Summarizing	Writing summaries	LOW
Re-reading	Studying the material again after initial reading	LOW
Keyword mnemonic	Using key words, mental images to associate with material	LOW
Text imagery	Attempt to memorize the material by creating mental images of the text	LOW
Highlighting	Marking, highlighting while reading	LOW

Common learning strategies and their effectiveness to achieve learning goals. Adapted from Dunlosky and Rawson (2015).

Choosing an appropriate and effective learning strategy is not a natural skill, neither is it taught explicitly at university. Students' and instructors' lack of awareness of various learning strategies and their effectiveness leads to students' learning gravitating around 'low' effectiveness learning strategies (Pressley, Goodchild et al., 1989; Bjork et al., 2013; Dunlosky & Rawson, 2015), which has a significant negative impact on students' performance (Gurung, 2005; Hartwig & Dunlosky, 2012).

3.2.5. Relevance of this study for Computer Science context

It is important to mention that apart from cognitive factors, the 'effectiveness' of learning strategies depends largely on content, resources, and students' personal attributes (Gravett, 2020; Chong, 2020; Hartwig & Dunlosky, 2012; Wissman et al., 2012). Contextual factors such as the academic discipline, the subject in this discipline, and even the moment, e.g., the beginning or the end of the program, have been identified to affect students' choices of learning strategies (Vermunt, 2005; Gurund et al., 2010). Undergraduates often face additional challenges when they start university, which makes it difficult for students to focus on effective learning and choosing the 'right' strategy for learning. Research suggests that like other STEM[3] programs, a Computer Science program has an overloaded curriculum and large amount of required seat time, which highlights the need to understand how students choose amongst various learning strategies (Seymour et al., 2019; Sheppard et al., 2009; Van den Bogaard, 2015; Van der Hulst et al., 2002; Becker & Fitzpatrick, 2019; Bennedsen & Caspersen, 2007; Watson & Li, 2014). At the same time, authors postulate that the majority of learning in Computer Science happens outside the classroom, which means that students are left to trust their own judgements in relation to how to learn effectively (Becker & Fitzpatrick, 2019; Bennedsen & Caspersen, 2007; Watson & Li, 2014). Bjork et al. (2013) pointed out that providing extra support to students in terms of how to learn effectively is crucial for students' academic success, especially, when students just enter the unknown learning environment. Moreover, scholars exploring different models of student success have concluded that student success during the first year shows indications for student success in later years (Kara et al., 2021; Naylor et al., 2015; Walker & Zhu, 2011). The start of a degree course is a difficult time for first-year bachelor students: it impacts their personal lives, their academic experience, and performance (Jenkins, 2002; Hodgson et al., 2010; Bangser, 2008; Chase, 1968; Boyer 1986; Madeja, 1981; Gaudin, 1984; Volpe, 1984, Gale & Parker, 2014; Perry et al., 2001; Cherif & Wideen, 1992).

[3] STEM is an acronym, consisting of four disciplines: Natural Sciences, Technology, Engineering and Mathematics (Wikipedia, 2024). Computer Science in STEM falls under the umbrella of Software Development which is a part of Technology major

Jenkins (2002) argues programming itself is explicitly difficult for first-year students since programming requires to develop and integrate knowledge, skills and attitude, often under time pressure. To master these complex competences students will need to use a mixture of different learning strategies, both low- and high-efficiency learning strategies, to succeed. In recent years enrolment in Computer Science has increased, leading to large class sizes in many institutions (Goode, 2007; Mulryan-Kune, 2010; Cervin-Ellqvist et al., 2020). Large classes are known to affect students' experience of learning, resulting in less personal interaction with instructors, increased passivity and reluctance towards learning (Robinson & Cooper, 2000; Bandiera et al., 2010). Passivity and reluctance affect students' motivation and impact students' ability to notice and accept instructional feedback (Robinson & Cooper, 2000; Bandiera et al., 2010). Students' judgements – accurate or not – determine how they approach learning (Carless & Boud, 2018).

Students have agency in determining how to react to instructional feedback, yet the associations between students' perceptions and student's learning strategies are poorly understood (Chong, 2020; Gravett, 2020; Winstone & Carless, 2019). Findings from this study will provide valuable insights into students' feedback perceptions and students' use of learning strategies, and aid in improving the process of giving instructional feedback, and helping students stay motivated and develop effective study strategies.

3.3. Method

3.3.1. Context of Delft University of Technology

Delft University of Technology is a leading technological research university in the Netherlands that focuses on training students to become high-skilled engineers. The Computer Science program at Delft University of Technology is capped at 500 incoming students every year (Delft University of Technology, 2022). Students are admitted based on the combination of subjects they took in high school, and based on a matching process where the program considers students' performance on pre-college work assigned by the Computer Science program. The Computer Science program is committed to supporting

students in becoming independent learners, as these are personal and academic qualities deemed paramount to the students' future careers (Faculty of Electrical Engineering, Mathematics and Computer Science, 2016; Tai et al., 2017).

The program of Computer Science redesigned their first-year: all first-year students are organized in peer groups of 15 learners in which students work on projects and home tasks together. Each group is overseen by a student mentor, usually a second-year bachelor student, who supports first-year students transitioning to university and acts as a teaching assistant (TA). Instructors are not involved in providing feedback to students personally, unless student's work requires grading. In the context of the object-oriented programming course taking place in the first quarter, students receive feedback during lab sessions and via an online platform called WebLab. Feedback from the online platform covers about the half of all assignments and does not only evaluate the code syntax, but also the goes beyond the surface-level corrections and focuses on the meaning and understanding behind a students' work. When students are unable to understand the logic behind their own mistakes, they can ask the TAs for additional feedback. Feedback from the TA's is oral. Feedback that students receive from TA's is both task- and process-oriented. Teaching assistants provide both oral and written feedback to students. The main source of written feedback is exams.

3.3.2. Instruments

We combined two validated instruments: The Motivated Strategies for Learning Questionnaire (MSLQ) and the Instructional Feedback Orientation Scale (IFOS).

The Motivated Strategies for Learning Questionnaire is a standardized, normed and validated instrument that is often used to measure learning strategies (Pintrich et al., 1991). The MSLQ has two main categories: (1) the Motivation category that assesses student's goals and beliefs about their personal skills, competences and the value of the course; and (2) the Learning Strategies category that assesses students' use of learning strategies (Turner, 1995; Pintrich et al., 1991). We chose the Motivated Strategies for Learning

Questionnaire because it includes a block on students' motivation, the aspects of which – self-efficacy and intrinsic factors – have been identified to act as a precursor to students' willingness to notice and accept instructional feedback (Handley et al., 2011; Chong, 2020; Carless & Boud, 2018).

In the original Motivated Strategies for Learning Questionnaire students rate themselves on statements using a seven-point Likert scale. Per recommendation by Wang and Krosnick (2019) we adjusted the scale to a six-point Likert-scale and left the middle answer option out, where 1='very untrue of me'; 2='untrue of me'; 3='somewhat not true of me;' 4='somewhat true of me'; 5='true of me'; 6='very true of me'. Previous studies on the Motivated Strategies for Learning Questionnaire that adjusted the scale to a 6-point Likert scale have not identified any significant impact of such a change on the instrument's reliability (Taherdoost, 2022). A detailed overview of all 15 sub-scales of the Motivated Strategies for Learning Questionnaire and their statements can be found in Appendix C.
To measure feedback perceptions, we used the Instructional Feedback Orientation Scale (IFOS) by King et al. (2009) as it explores "perceptual dimensions of instructional feedback" (p. 236). Feedback orientation, as defined by London and Smither (2002), refers to an individual's overall receptivity to feedback. It encompasses how individuals seek, process, and use feedback to enhance their learning or performance. In this paper, feedback orientation is aligned with the concept of feedback perceptions, which we use throughout the manuscript to describe how students perceive, interpret, and engage with instructional feedback. We were particularly interested in how students comprehend, perceive, and value feedback information that is provided to them, as opposed to how students conceptualize feedback more generally (Brown & Zhao, 2023). The Instructional Feedback Orientation Scale includes four categories (see Appendix D) (1) Feedback Utility (students' perceived usefulness of instructional feedback); (2) Feedback Sensitivity (students' cognitive or behavioural sensitivity in response to instructional feedback); (3) Feedback Confidentiality (students' preference in public or private context when provided with instructional

feedback); and (4) Feedback Retention (students' ability to understand, recall and accept instructional feedback provided to them) (King et al., 2009).
For the Instructional Feedback Orientation Scale students indicate their level of agreement to the statements about instructional feedback on a 6-point Likert scale: 1='strongly disagree'; 2='disagree'; 3='somewhat disagree'; 4='somewhat agree'; 5='agree'; 6='strongly agree'.

The questionnaire consisted of 108 statements (81 for the Motivational Strategies for Learning and 27 for the Instructional Feedback Orientation Scale). We added questions on student demographics on student's personal demographic info to check for representativeness (Appendix H). The administration time of the questionnaire was approximately 30 minutes. We administered the questionnaires in the first semester of the first year to explore students' feedback perceptions and students' learning strategies during the important period of transitioning to university learning environment. Below we discuss the participants, the data and the methods of analysis.
Below we discuss the participants, the data and the methods of analysis.

3.3.3. Human Research Ethics, Participants, Data Cleaning

This study was approved by the Human Research Ethics Committee of Delft University of Technology under case number 72399. None of the research team members had any involvement in the Computer Science educational program. The online questionnaire was sent to all the first-year students of Computer Science at Delft University of Technology in September 2020. Students were sent 3 reminders. In total, 214 students participated in the questionnaire. All participants signed an informed consent form. Students' demographics reflected in the sample was representative for the population.

We reverse coded the reversed items, all identifying information was removed from the data, and the variables were examined for missing values. All variables had between 1 and 3.1 percent missing cases, however, there we did not find any patterns to the missing data

through application of the T-test (Musil et al., 2002). We removed outliers for age and we removed students who had prior experience with higher education learning environment, for example, students who switch to different university or program.
The final dataset consisted of 97 participants: 76 males, 19 females, and 2 participants preferred not to specify.

3.3.4. Initial analysis of the scales

We analysed the scales of both instruments using exploratory factor analysis (EFA) based on the sample. Since we chose a validated instrument with a strong theoretical foundation for each scale, we were interested in confirming the simple structure of the instruments in our population, for which EFA using a principal component analysis is an appropriate test (Watkins, 2018; Le et al., 2010; Brown, 2015; Field, 2009).

In our sample the number of data points is small relative to the number of items in the questionnaire. There are different perspectives on what is considered the appropriate sample size for EFA, see e.g., Gorsuch (1983), Cattell (1978), MacCallum (2001), Bujang et al., (2012), and Preacher and MacCallum (2001) who all argue for certain proportions between datapoints and questionnaire items. However, their work argues for large sample sizes which is not always in reach in clinical studies in, for example, genetics or education (Preacher & MacCallum, 2001). Instead, we followed the guidelines and recommendations summarized by De Winter, Dodou, and Wieringa (2009). They found based on various Montecarlo simulations that small sample sizes can yield reliable results under certain conditions: factors are well defined, commonalities are high, data is normally distributed, and the number of factors is limited.

Analyses were conducted separately for the Motivated Strategies for Learning Questionnaire and the Instructional Feedback Orientation Scale. Our sample fits the conditions presented by de Winter et al. (2009): for the Instructional Feedback Orientation Scale as our four factors are well-defined: they are standardised and have been found to be

valid in several research contexts (Kasch et al. 2022; King et al. 2009; Linderbaum & Levy 2010); all our commonalities are high ranged between 0.6 and 0.8. Moreover, according to Mundfrom et al. (2005), with higher levels of communalities, the minimum sample size can be smaller than recommended. Following the recommendations of Stevens (2002), Mundfrom et al. (2005), and Guadagnoli and Velicer (1988) for a sample size up to 100 data points communalities were considered significant at 0.6, therefore only factor communalities above 0.6 were analysed.

We used principal components factor analysis based on the correlation matrix and we applied a Varimax rotation to maximize the loadings variance for factors across items, using eigenvalues >1 as criterion. In the first stage of the analysis only factor commonalities above 0.6 were analysed (Guadagnoli & Velicer, 1988). A KMO value of 0.81 was obtained for the Instructional Feedback Orientation Scales. KMO values of 0.5 are the minimum threshold for adequate sample size, as values around .80 indicate an adequate sample size (Kaiser & Rice, 1974). The internal consistency of each scale was calculated using Cronbach's alpha (α). Values ranged from 0.79 – 0.90 (see Table 2.2), and Field (2009) suggests a minimum threshold of $\alpha > 0.70$. Cronbach's alpha reliabilities were satisfactory for all scales; therefore, no scales nor items were removed. Means, standard deviations and medians for individual items within each scale of the Instructional Feedback Orientation Scale are presented in the Appendix E.

Table 2.2. Students' feedback perceptions: mean, standard deviation and median

IFOS scales	Mean	Standard Deviation	Median	α
Feedback Utility	4.81	0.769	5.00	0.906
Feedback Sensitivity	2.88	0.647	3.00	0.806
Feedback Confidentiality	3.69	1.064	4.00	0.803
Feedback Retention	2.71	0.973	3.00	0.794

Mean, standard deviation and median values reported by students per each of the four dimensions of the Instructional Feedback Orientation Scale. Values are based on Likert scale scores from 1 serving as 'strongly disagree' to 6 indicating 'strongly agree'.

We submitted the pool of items of the MSLQ to the same analysis as the IFOS items and we used the same procedure of principal components factor analysis based on the correlation matrix with a Varimax rotation. A KMO value which indicates sampling adequacy of 0.79 was obtained for the Motivated Strategies for Learning Questionnaire. Value close to 0.8 indicate adequate sample size (Kaiser & Rice, 1974). The internal consistency of each scale was measured with Cronbach's alpha (α). The means, standard deviations, medians, and the Cronbach's alphas are presented in Table 2.3.

Table 2.3. Means, Standard Deviations, Medians, and Internal Consistency (Cronbach's alpha) of the MSLQ scales

MSLQ scales	Mean	Standard Deviation	Median	α
Value Component: Intrinsic Goal Orientation	4.43	0.797	4.50	0.715
Value Component: Extrinsic Goal Orientation	4.00	0.888	4.00	0.583*
Value Component: Task Value	4.67	0.821	4.83	0.880
Expectancy Component: Control of Learning Beliefs	4.90	0.743	4.00	0.753
Expectancy Component: Self-Efficacy for Learning and Performance	4.29	0.820	4.37	0.908
Affective Component: Test Anxiety	3.60	1.032	3.60	0.797
Cognitive and Metacognitive Strategies: Rehearsal	3.38	1.065	3.50	0.721
Cognitive and Metacognitive Strategies: Elaboration	4.26	0.756	4.33	0.793
Cognitive and Metacognitive Strategies: Organization	3.60	1.095	3.50	0.788
Cognitive and Metacognitive Strategies: Critical Thinking	3.68	0.852	3.80	0.781
Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation	3.89	0.600	3.83	0.714
Resource Management: Time and Study Environment	4.00	0.804	5.00	0.762
Resource Management: Effort Regulation	4.10	0.926	4.25	0.717
Resource Management: Peer Learning	3.50	1.055	3.66	0.652*
Resource Management: Help Seeking	3.35	0.930	3.50	0.576*

Note. Cut off scores for reliability of MSLQ scales was set at $\alpha > 0.70$ (Field, 2009)

* These scales were removed from the study because of the low scale reliability (Field, 2009)

Following Field's (2009) recommendation of a minimum threshold for Cronbach's Alpha of .70 the following scales were removed:

1. Motivation category Value Component: Extrinsic Goal Orientation sub-scale

2. Learning Strategies category Resource Management: Peer Learning sub-scale
3. Learning Strategies category Resource Management: Help Seeking sub-scale

3.4. Results

3.4.1. Instructional Feedback Orientation Scale: students' feedback perceptions

When we look at the scores within the scales, the students generally have positive perceptions of instructional feedback (Feedback Utility sub-scale mean 4.81, standard deviation 0.769, median 5.00). Low scores in the Feedback sensitivity sub-scale imply that students are not hurt by the feedback they receive, however, the scores in the Feedback Confidentiality sub-scale vary between 3 and 4, where 3 = 'somewhat disagree', and 4= 'somewhat agree'. This indicates that students are not sure whether or not they prefer to receive feedback in private or in public. The high standard deviation (SD 1.064) confirms students' wide variety of responses. Low scores in the Feedback Retention sub-scale indicate that students do not experience difficulties recognizing, decoding and recalling the instructional feedback when they receive it. However, the scores of each individual item within the sub-scale show contradictions in students' responses (Appendix E). The statements of the Instructional Feedback Orientation scale where most students score high, are: "I listen carefully when an instructor provides feedback" (mean 5.04, standard deviation 0.904, median 5.00); and "I pay careful attention to the feedback that instructor gives" (mean 4.94, standard deviation 0.917, median 5.00). At the same time the highest reported item amongst all four scales is "Feedback from instructors is a waste of time" (mean 5.23, standard deviation 0.979, median 5.00), indicating the students' attitude towards the usefulness of instructional feedback is muddled. Some of the scale items receive relatively low scores and high standard deviations: not all students believe that instructional feedback provides clear directions and suggestions for improved learning (mean 4.69, standard deviation 1.166, median 5.00); some students report they do reflect on the feedback they receive (mean 4.5, standard deviation 1.235, median 5.00); and other students feel encouraged and motivated by feedback that was provided (mean 4.61, standard deviation 1.041, median 5.00).

In the Feedback Sensitivity sub-scale, students report high scores on the statement: "It is difficult to 'get over' corrective feedback" (mean 4.99, standard deviation 1.087 and median 5.00). According to the Instructional Feedback Orientation Scale description (King et al., 2009), the Feedback Sensitivity subscale reports on how instructional feedback makes students feel: whether students feel hurt, intimidated and offended by instructional feedback or not. High scores for this item in the Feedback Sensitivity sub-scale indicate that the most students in the sample feel intimidated by instructional feedback and find it hard to process the instructional feedback without feeling hurt. Other items in the Feedback Sensitivity sub-scale had high standard deviations and lower medians (see Appendix E). These results indicate a large variability of students' reported feedback perceptions in relation to students' emotional sensitivity, meaning that some students in our sample feel threatened by instructional feedback, while others do not. In our sample students score low on the Feedback Confidentiality and the Feedback Retention sub-scales: all items in these sub-scales have relatively low means and medians, while standard deviations remain high. The Feedback Confidentiality scale reports on students' preferences to receive feedback in private or in public. Low scores on this scale, combined with high standard deviations indicate that there is no clear preference in our sample on how instructional feedback should be given. The Feedback Retention sub-scale reports on students' ability to remember and recall the instructional feedback provided to them.

3.4.2. The Motivated Strategies for Learning Questionnaire: Students' Motivation and Learning Strategies

Item scores for the Motivated Strategies for Learning Questionnaire sub-scales are presented in Appendix F. For each item we report the mean for central tendency, standard deviation and median. We discuss the scores on the sub-scales below.

In the Motivation category students report positive outcomes for 4 sub-scales, indicating that the students in the sample tend to be highly motivated. These sub-scales are:

1. Value Component: Intrinsic Goal Orientation sub-scale
2. Value Component: Task Value sub-scale
3. Expectancy Component: Control of Learning Beliefs sub-scale
4. Expectancy Component: Self-Efficacy for Learning and Performance sub-scale

The sub-scales Test Anxiety and Extrinsic Goal Orientation score slightly lower, which might indicate that the students are not yet focused on the challenges of exams and extrinsic rewards at the time the data was collected. The majority of students rate their motivation and self-beliefs related to the program highly: students report that they are confident in their ability to learn the materials in the course effectively (mean 5.19, standard deviation 0.802, median 5.00), students also state that appropriate effort leads to sufficient results (mean 5.16, standard deviation 0.773, median 5.00). Yet the following statement shows a high standard deviation: “If I do not understand the course material, it is because I didn’t try hard enough” (mean 4.44, standard deviation 1.258, median 5.00), an item that is part of the same sub-scale Control of Learning Beliefs. The score on this item seems to contradict other items in the same sub-scale.

Intrinsic Goal Orientation receive lower values compared to other scales in the Motivation Category: “In a class like this, I prefer course material that really challenges me so I can learn new things” (mean 4.43, standard deviation 1.079, median 5.00) and “In a course like this, I prefer course material that arouses my curiosity, even if it is difficult to learn” respectively (mean 4.69, standard deviation 1.082, median 5.00).

3.4.3. Students’ learning strategies

Responses on the learning strategies sub-scales have large distributions compared to responses on items in the IFOS scales. On the Effort Regulation scale, for example, students report high values for the item “When course work is difficult, I either give up or only study the easy parts” (mean 4.39, standard deviation 1.274, median 5.00).

Responses on the Metacognitive Self-Regulation learning strategy scale have large distributions in our sample (means varied from 4.85 (SD = 0.77 and median = 5.00) to 3.07 (SD= 1.462 and median = 3.00)), indicating that students are not confident in using these learning strategies or they might not use any learning strategies at all. It is striking that students do not report using learning strategies based on metacognitive self-regulation that have moderate to high utility for student learning (see Table 1) (Dunlosky & Rawson, 2015). Five learning strategies show large distributions of means, standard deviations and medians. Large distributions of students' responses on these learning strategies show that some students use the learning strategies, while other do not. These strategies include:

-Rehearsal (activating of information in working memory);

-Organization (organizing information);

-Critical thinking (evaluating prior knowledge in relation to new knowledge);

-Peer Learning (collaboration with peers); and

-Help Seeking (searching, finding and asking assistance)

3.4.4. Associations between students' feedback perceptions and students' motivation and learning strategies

We explored the relations between the feedback perceptions as measures through the Instructional Feedback Orientation Scale and the Motivation and Learning Strategies from the Motivated Strategies for Learning Questionnaire. We performed a Spearman' correlation with 13 scales of the Motivated Strategies for Learning Questionnaire and 4 scales of the Instructional Feedback Orientation Scale.

To answer the research question on how feedback perceptions and strategies for learning and motivation are related, we performed a Spearman correlation analysis between the sub-scales of the Motivated Strategies for Learning Questionnaire and the Instructional Feedback Orientation Scales (Table 2.4).

Table 2.4. Correlation values between variables of the MSLQ and the IFOS

		Feedback Utility corr / p-value	Feedback Retention corr / p-value	Feedback Sensitivity corr / p-value	Feedback Confidentiality corr / p-value
Motivation Category	Value Component: Intrinsic Goal Orientation	.306/.007	.380/.001	-.120/.295	-.149/.192
	Expectancy Component: Self-Efficacy for Learning and Performance	-.231*/.042	.438/.001	-.218/.055	.176/.122
Learning Strategies Category	Cognitive and Metacognitive Strategies: Rehearsal	.399/.001	-.110/.341	.108/.346	-.095/.407
	Cognitive and Metacognitive Strategies: Elaboration	.445/.001	.395/.001	-.127/.266	-.109/.341
	Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation	.458/.001	.353/.002	-.171/.133	-.243/.032
	Resource Management: Time and Study Environment	.212/.062	.423/001	-.228*/.045	-.002/.984
	Resource Management: Effort Regulation	.304*/.007	.522/.000	-.218/.055	.001/.992

Note. Correlation and p-values between variables of the MSLQ and the IFOS scales reported by students in our sample.

* Correlation is significant at the 0.05 level (2-tailed)

Two scales of the Instructional Feedback Orientation Scale - Feedback Utility and Feedback Retention, showed positive correlations to four and six scales of the Motivated Strategies for Learning Questionnaire respectively. Feedback Utility had a positive correlation with Intrinsic Goal Orientation (r_s=.30, p<.007) from the Motivation category; and three learning strategies from the Learning Strategies category: Rehearsal Learning Strategy (r_s=.39, p<.001), Elaboration Learning Strategy (r_s=.44, p<.001) and with Self-Regulation Learning Strategy (r_s=.45, p<.001).

Intrinsic Goal Orientation represents students' perception of the reasons to engage in learning. Together with Self-Efficacy, Intrinsic Motivation is responsible for activating the 'right' mindset of students to engage into instructional feedback (Handley et al., 2011).

Feedback retention had a positive correlation with Self-Efficacy for Learning and Performance (r_s= .43, p<.001) and Intrinsic Goal Orientation (r_s=.38, p<.001) from the Motivation category. Feedback Retention represents students' ability to understand and accept instructional feedback. Self-Efficacy for Learning and Performance represents judgements of one's ability to engage with provided feedback. These findings show that when students are able to understand and accept feedback messages from instructors, students show confidence to complete the task or assignment. The correlation with the Intrinsic Goal Orientation sub-scale indicates students' personal reasons and values to engage with feedback when the feedback message is understood and accepted.

Feedback Retention also showed positive correlations with multiple learning strategies: Metacognitive Self-Regulation (r_s=.35, p<.002), Time and Study Environment (r_s=.43, p<.001), Effort Regulation (r_s=.53, p<.001), and Elaboration (r_s=.39, p<.001). Time and Study Environment is a learning strategy that reflects on scheduling, planning and managing one's own time to study, yet also represents the students' ability to set realistic learning goals. Effort Regulation is a learning strategy that reports on students' ability to control one's effort, attention, and focus. Correlations between Feedback Retention and Self-Regulation indicate that students are able to regulate their own cognition and behaviour to improve learning when they understand the feedback message and accept it. Correlations with the

Time and Study Environment learning strategy shows that understanding and accepting instructional feedback has positive relationships with students' ability to schedule, plan learning as well as setting realistic goals. Positive relationships between understanding and accepting instructional feedback are also present with students' abilities to organize and manage appropriate resources by means of the Effort Regulation learning strategy. Finally, strong relationships between Feedback Retention and the Elaboration learning strategy indicate that when students understand and accept instructional feedback, they are able to connect new information to prior information and store information in long-term memory. Students' perception of feedback had strong positive correlation with students' motivation and students' use of several effective learning strategies.

3.5. Discussion and Conclusions

3.5.1. Discussion

In this paper we explored the relationship between students' feedback perceptions and students' motivation and learning strategies in the context of a first-year program in Computer Science. The literature review suggested there are many variables involved in how students perceive feedback, what motivates students to engage with feedback, and what learning strategies students actually use (Chong, 2020; Carless & Boud, 2018; Gravett, 2020; Van der Kleij & Lipnevich, 2020; Carless & Winstone, 2019). Our results are mixed: while the scales on feedback's perceived usefulness show positive scores, students provide contradictory responses on multiple items of these scales. For example, students have positive opinions about feedback use; however, at the same time they report that they deem feedback a waste of time. It is unclear why students believe that 'feedback is a waste of time'. We argue that there might be a missing link between students' (un)willingness to accept and apply instructional feedback: for example, when students do not get the feedback they expect, they do not always recognize feedback for what it is, or the feedback message is not well understood. Jonsson (2013) argues that besides perceived feedback utility there are other important factors that influence what students do with instructional feedback. One of the key factors Jonsson (2013) mentions is students' lack of strategies to

use instructional feedback productively, and their lack of understanding of contextual variables. Contextual variables, such as the content, the learning environment, the feedback providers themselves – TAs in this case - contribute to the specific conditions that influence how feedback is provided and received. Such conditions are analysed and discussed by Fuller (2013) and in his subsequent works (2015; 2016; 2017). Fuller (2013) argues that the context of the learning environment and academic staff involved in teaching and assessing the program contribute to the cultural underpinning of certain feedback types and methods to be favourable within this specific program. We argue that this conundrum requires further research. Besides context, there has been limited research into the other key factors identified by Jonsson (2013).

Our results show that the way students perceive instructional feedback has strong relationships with students' motivation to engage with instructional feedback and learning strategies that students use to apply the instructional feedback they receive. Looking at the correlations between students' feedback perceptions, students' motivation and students' reported learning strategies the following picture emerges: when students are able to understand and willing to accept the instructional feedback, students show confidence in completing the task. Simultaneously, students' reasons to engage in learning and improve it is positively influenced. These findings indicate the key condition to promote students' engagement with instructional feedback - it is important to make sure students understand instructional feedback. Carless and Boud (2018), and Handley et al. (2011) confirm that students' understanding of instructional feedback and their willingness to accept provided feedback to improve their work is one of the most crucial precursors for effective uptake of instructional feedback.

Students' perceived usefulness of feedback also correlated strongly with students' intrinsic values and self-efficacy, suggesting that for students to engage with feedback and have confidence in their ability to complete the tasks, the feedback message needs to be perceived as useful. These findings complement the work of Winstone et al. (2017) and

Sadler (1989, 2010), who established that - although students find feedback important - the use of feedback is often limited due to students' difficulties decoding instructional feedback and applying the feedback to improve learning.

Our findings also show that students' perceived usefulness of instructional feedback and students' ability to understand and accept feedback messages are an important condition for students' intrinsic motivation and self-efficacy. Students' perceived usefulness of feedback and understanding of feedback messages also correlated positively with several learning strategies that focused on the ability to manage various resources, e.g., time, effort, information, cognition and behaviour, to improve learning. Similar results were discussed by Strijbos et al. (2021) who used the Feedback Perception Questionnaire (FPQ) to examine students' feedback perceptions. Results showed that perceived usefulness and fairness of feedback correlated positively with students' willingness to improve and affect and were confirmed to be strong predictors of students' engagement with feedback to improve one's learning. In the context of engineering Coppens et al., (2024) used FOS, SRIS (Self-Reflection and Insight Scale) and reflective logs to explore students' feedback literacy. Their study showed a significant decline in scores on the utility scale of FOS in the first semester. The authors did not explore the underlying reason behind such decline of students' understanding of feedback, however, they hypothesize that the decline in scores on the utility scale might be due to the period of adaptation to the university, since second semester showed significant increase on the same scale. Coppens et al. (2024) and Strijbos et al. (2021) did not examine students' learning strategies in relation to students' feedback perceptions, yet both studies conclude that students need motivation, opportunities and means to act on instructional feedback (Strijbos et al., 2021; Coppens et al., 2024; Tai et al., 2017; Boud et al., 2013, 2015; Boud & Molloy, 2012). We found it striking that the scales of the Motivated Strategies for Learning Questionnaire, in particular learning strategies Resource Management, Help Seeking and Resource Management, and Peer Learning had to be removed from the analysis due to inconsistencies in the reported values. It is not clear why these learning strategies received mixed scores from the students, however, Vilkova

and Shcheglova (2020) focused on exploring the help-seeking mechanisms in self-regulated learning amongst the MOOC students. Vilkova and Shcheglova used the OSLQ (Online Self-Regulated Learning Questionnaire) that is also used to explore students' motivation and learning strategies but in online and blended learning contexts (Broadbent et al., 2022). Vilkova and Shcheglova (2020) report they removed the help-seeking scale from their analysis because of reliability issues of the scale in their sample. They hypothesise that help-seeking behaviour might not be common in large scale learning environments, such as MOOCs, due to the low communication between students and instructors. As such, there are similarities between MOOCs and large face-to-face learning environments where students tend to perceive low communication between them and their instructors too.

It is paramount to ensure students understand the instructional feedback they receive, and to support students in developing effective learning strategies if we aim for students to use instructional feedback. However, meeting these challenges does not guarantee improvements in student learning (Smits et al., 2008). Van der Kleij and Lipnevich (2020) argue that, even when feedback is perceived as useful, it does not always lead to students' active engagement with feedback, since students' preferences of certain type of feedback do not always align with students' motivation to act upon instructional feedback, or the use of learning strategies that are beneficial for student learning in the long run (see also Smits et al., 2008). Moreover, the concept of 'usefulness' is perceived differently among students, which suggests that instead of focusing on making feedback useful, it is important to promote feedback literacy and the use of highly effective learning strategies to increase students' engagement with instructional feedback (Chong, 2020, Carless & Boud, 2018, Van der Kleij & Lipnevich, 2020; Smits et al., 2008; Brown & Zhao, 2023). There is a great need for more empirical research into how exactly students take actions in relation to instructional feedback and what exactly students do when instructional feedback is provided to understand how students can be supported on the way to develop their feedback literacy.

3.5.2. Conclusions

To answer our research question – whether feedback perceptions have an association with learning strategies, we performed a correlation analysis. We found significant correlations between how useful students perceive feedback to be and how well students understand the feedback, and students' intrinsic motivation and self-efficacy. Students' perceived usefulness and understanding of feedback also correlated with several learning strategies aimed to organize, activate and self-regulate the learning process. In the following paragraph we discuss possible suggestions useful for instructors, limitations of this study, and future directions for this research.

3.5.3. Limitations

The main limitation of this study pertains to the sample size, which limits the generalizability of this study. De Winter et al. (2009) report that using small N for EFA may yield robust results, however, they remark that generalizability will be limited. The low response might be connected to the length of the questionnaire. Long questionnaires might cause survey fatigue, also known as overexposure to the survey process and impacts students' willingness to complete questionnaires (Porter et al., 2004; De Heer, 1999). Another possible reason for the low responses is that students may not see the use of completing the questionnaire or believe their opinions do not matter. Additionally, our study is based on cross sectional data, and may be influenced by volunteer bias.

3.5.4. Practical implications

Carless and Boud (2018) postulate that instructors have limited agency on how students perceive feedback, however, this study may inspire instructors to shape their feedback practices in such a way they encourage students to develop a mindset to notice feedback, to find its use and encourage students to use provided feedback by suggesting appropriate learning strategies. An effective strategy could be to follow-up on provided feedback in lectures, and discussing with students how they could use it. General guidelines, derived from this study, would be not to assume students are able and competent to choose

of the purpose of feedback and appropriate learning strategies that fit the learning goals and content, instructors may positively influence the extent to which feedback is applied by students.

3.5.5. Future directions

Given the increased interest in feedback perceptions, we believe that it is important to focus on how those perceptions are created, and how student use their strategies for learning based on their feedback perceptions. More empirical research is needed to capture these nuances, and explore how and why students use certain learning strategies.

Our results show that students report feedback as a waste of time, and we believe it would be essential to capture experiences, opinions, perceptions and reasons behind those responses. Future qualitative research with the same students would provide more clarity on why students think feedback is a waste of time. Future quantitative research should enable subgroup analysis based on relevant education experiences.

The results of this study, as well as the work by e.g., Karaca and Osak (2017), show that students in Computer Science may have different learning strategies compared to students in other fields, such as, for example, Arts or Humanities. It would be important to investigate how and to what extend the learning environment in Computer Science, and in particular the way students learn to program, influences students' choices regarding learning strategies, motivation and feedback perceptions. In this study we collected data only at the start of the first year, yet it would be important to explore if and how students' feedback perceptions and students' learning strategies change overtime using a longitudinal approach that can capture such change.

Chapter 4. Towards better understanding of instructional feedback application

Mixed-method study

This chapter has been submitted to Computer Science Education in adapted form as:
van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. Towards better understanding of instructional feedback application: mixed-method study.

4.1. Introduction

Students' engagement with instructional feedback is a well-known challenge in higher education (Carless et al., 2016). On one hand, instructors have limited agency influencing students' motivation to engage with instructional feedback (Van der Kleij & Lipnevich, 2020). Long term belief that when students are simply told what to do, students engage with instructional feedback, had been debunked by recent advancement in feedback research in higher education (Torrance, 2012; Winstone et al., 2017). There is scientific evidence that students have an active role in deciding whether or not they are willing to accept instructional feedback and use it for learning, even when feedback is seen as useful (Handley et al., 2011; van der Kleij & Lipnevich, 2020). On another hand, a plethora of lately emerging studies claim than even when students are willing to engage with instructional feedback, students employ ineffective learning strategies that do not result in improved learning (Cervin-Ellqvist et al. 2020; Bjork et al., 2013; Dunlosky & Rawson, 2015).

Understanding how students use instructional feedback is essential in order to promote the use of effective learning strategies amongst the students. For example, when transitioning to higher education, students are often exposed to 'self-responsible', independent learning with majority of learning happening outside of the lectures, therefore successful use of effective learning strategies in the first year lays strong foundation for students to succeed in learning in later years (Cervin-Ellqvist et al. 2020; Shaziya, 2015; Zimmerman, 1990; Felder and Brent, 2004; Credé & Kuncel, 2008; Richardson et al., 2012). Students who succeed in the first semester tend to keep their academic performance on a high level throughout the entire study programme, which in turn leads to career prospects (Ohland et al., 2009, Feng & Graetz, 2017; Kara et al., 2021; Naylor et al., 2015; Walker & Zhu, 2011). Contrary to the expectations of the higher education institutions, students fail to engage into effective learning strategies, and often employ learning strategies that are not beneficial for learning in a long run (Bjork et al., 2013).

The importance of use of effective learning strategies in response to instructional feedback is particularly evident for students of large classes, which is the case for many Computer Science programs: due to rapidly increasing enrolment rates in Computer Science higher education, Computer Science classes are often large in student numbers (Hao et al., 2019). Large classes make it significantly difficult for instructors to dedicate sufficient time to provide appropriate feedback for students' assignments (Kara et al., 2021; Exeter et al., 2010; Mulryan-Kune, 2010; Maringe & Sing, 2014, Hornby & Osman, 2014; Cheng, 2011; Monks and Schmidt, 2011; Bandiera et al., 2010; Ehrenberg et al., 2001; Cuseo, 2007). The programming course is the core subject in Computer Science and it is particularly challenging in terms of application of instructional feedback: a) programming requires managing several layers of abstraction simultaneously: syntax, logic, algorithms, debugging strategies and problem-solving domain; which imposes a heavy cognitive load on students; b) feedback in programming often needs to address low-level syntactic error and high-level conceptual misunderstanding simultaneously, which makes it difficult for students to focus on high-level instead of syntax errors (Sweller, 1988; Shute, 2008; Becker, 2016; Lahtinen et al., 2005). Instructional feedback in programming is often given automatically by learning environment itself, which means that instructional feedback is often delivered to students as information to digest, with little to no opportunity for further communication, clarifying or suggestions for next steps in learning (Hao et al., 2019).

One common strategy to address this issue is to investigate the design of the instructional feedback to design the feedback message to be seen as 'useful' for students. However, this strategy neglects the elevated agency of each student's individual response to instructional feedback. Understanding how students perceive instructional feedback and how students use instructional feedback is crucial to promote effective learning strategies that have positive impact on students' learning in a long run.

To fill this gap, this study investigates the use of various learning strategies in response to instructional feedback amongst first-year undergraduate students of large

classes in Computer Science education during the first semester. This study contributes to a deeper understanding of how students perceive instructional feedback and how those perceptions translate into students' motivation to engage with instructional feedback and students' use of learning strategies. Using a mixed-method research design, with data gathered through a questionnaire and semi-structured group interviews with students, this study is guided by the following research question:

(RQ1) How do students of large classes in Computer Science program perceive instructional feedback?

(RQ2) What learning strategies and motivation do students of large classes in Computer Science program report for applying the instructional feedback they receive?

With the help of these questions, we help to advance the understanding of what learning strategies Computer Science students use in response to instructional feedback they receive during the first semester at the university. Addressing these questions is the key to promote learning strategies that are beneficial for students' learning in the long run.

4.2. Background

4.2.1. Instructional feedback and feedback perceptions

Instructional feedback has proven to be a powerful tool to support students in learning (Hattie & Timpereley, 2007). Both types of feedback: summative and formative, guide students throughout the process of learning providing evaluation on the quality of learning. Formative feedback provides continuous evaluation on where students are in learning, where are they going and how to reach their learning goals (Nicol & Macfarlane-Dick, 2006). Summative feedback assesses students' knowledge and performance against the standard criteria or certification (Brinko, 1993; Gielen et al., 2010). Both types of feedback, when in balance, serve as a guidance tool for students to navigate their learning process.

Given the benefits of appropriate feedback on students' learning, instructors allocate time and effort in crafting feedback practices that enhance students learning. However, contrary to the expectations of the instructors, instructional feedback is often ignored or overlooked by students – deliberately or not (Boud & Molloy, 2012; Butler & Winne, 1995; Shute, 2008; Kluger & DeNisi, 1996). Van der Kleij et al. (2015) suggested that students' individual feedback perceptions is the missing link between the instructional feedback that was intended by the instructors and the feedback that is perceived by students. Students' feedback perceptions include various aspects of feedback message, feedback provider and learning environment that influence how feedback is viewed by students, and whether or not such instructional feedback will be applied. This view of instructional feedback highlights the limited agency of instructors in students' engagement with feedback; and stresses the importance of individual agency of each student in willingness to engage with instructional feedback (Van der Kleij & Lipnevich, 2020).

4.2.2. Feedback perceptions and students' motivation to engage with instructional feedback

Feedback perceptions partially explain students' decision-making in whether or not to use instructional feedback provided to them. However, even positive feedback perceptions do not always result in improved learning amongst the students (Van der Kleij & Lipnevich, 2020). For example, students might see instructional feedback as useful, but still decide to not engage with or fail to proceed with subsequent actions. Handley et al. (2011) suggested to differentiate between the process of students' recognizing and accepting of instructional feedback; and the process of drawing an actual plan to use instructional feedback. The difference between those processes lies in students' motivation: without the 'right' mindset that includes students' willingness to accept instructional feedback and act on it, students do not proceed with feedback application. Such aspects of students' motivation as self-efficacy and intrinsic motivation play an important role in students' subsequent actions towards instructional feedback application: high levels of self-efficacy – students' beliefs that their actions can produce the desired outcomes – are strong precursors to students'

willingness to engage with instructional feedback (Handley et al., 2011; Pajares, 2012; Butler & Winne, 1995; Kluger & DeNisi, 1996). Similar findings were revealed about students' intrinsic motivation: students' intrinsic goal orientation – striving for mastery, curiosity, challenge in learning – act as a strong predictor to students' 'right' mindset towards instructional feedback (Pintrich et al., 1991; Agricola et al., 2019; Handley et al., 2011). Since students' feedback perceptions include a large number of various aspects that influence how students perceive feedback, these aspects also impact students' mindset and willingness to accept feedback (Handley et al., 2011; Hargreaves & Fullan, 2012; Nicol et al., 2014; Carless, 2006; Havnes et al., 2012; Jonsson & Panadero, 2018). For example, bad relationships with the instructor impact students' motivation to accept this instructor's feedback, or previous negative experience with instructional feedback impacts students' self-efficacy (Brookhart, 2018; Gamlem & Smith, 2013; Havnes et al., 2012). Since students' willingness to accept instructional feedback is an important condition for students' subsequent actions in applying this feedback, it is important to investigate what feedback perceptions student have and what motivation student exhibit in response to these feedback perceptions.

4.2.3. Instructional feedback application: students' use of learning strategies

For learning to be effective, students do not only need to have the 'right' mindset towards instructional feedback, another important condition is the use of effective learning strategies (Van der Kleij & Adie, 2020; Cervin-Ellqvist et al., 2020).

Ideally, when students are willing to act on instructional feedback, the action plan is drawn to apply such feedback and improve learning (Handley et al., 2011; Bjork et al., 2013). However, a common assumption here is that students are entering the university equipped with effective learning strategies, aware of their cognitive effectiveness and knowledgeable to use such learning strategies accurately and appropriately regarding their learning goals (Bjork et al., 2013; Cervin-Ellqvist et al., 2020). In reality, however, successful use of effective learning strategies is a skill in itself (Biggs, 1999, Bjork et al., 2013). Bjork et al (2013)

postulate that learning skills and effective learning strategies do not come to students naturally, nor are they explicitly taught to students in higher education (Bjork et al., 2013; Servin-Ellqvist et al., 2020). Students who enter universities have developed certain skills to learn in secondary education, however, those learning strategies tend to be constructed mostly around simple memorization and reproduction of prior knowledge (Exeter et al., 2010; Dunlosky & Rawson, 2015). According to Dunlosky & Rawson (2015), such learning strategies are counterproductive.

4.2.4. Learning strategies in Computer Science context

It is important to mention that the relative effectiveness of learning strategies depend not only on cognitive factors, but also on the learning context and academic discipline (Vermunt, 2005; Afshar et al., 2014; Gurung, 2005). The context of large, Computer Science learning environment is exceptionally challenging for students to develop effective learning strategies. Computer Science classes are often large (Hao et al., 2019; Falkner et al., 2014), which significantly lowers opportunities for instructors to provide sufficient support and guidance for each student to help develop effective learning strategies (Voghoei et al., 2020; Agricola et al., 2019; Hao et al., 2019). Students in large classes often fail to develop meaningful connections with peers as well (Ford-Eickhoff & Kane, 2019; Hornsby-Osman, 2014; Ward and Jenkins, 1992), which results in students' increasing reluctance to develop or reflect upon learning strategies that involve peers (Mulryan-Kune, 2010; Ford-Eickhoff & Kane, 2019). Computer Science classes are often diverse in prior knowledge, as large number of students enter the program with little to no experience in discipline (Falkner et al., 2014). Novices in this area lack well-organized skills and knowledge to produce effective problem-solving processes required for Computer Science courses. Novice learners are unskilled in planning, they struggle to understand the complex concepts due to the lack or prior knowledge, and tend to solve problems by engaging with techniques emerged from surface knowledge of programming language resulting in 'local repairs' (Falkner et al., 2014; Robillard, 1999; Veenman et al., 1997). Moreover, instructional feedback in Computer Science education is often automated (Keuning et al., 2019; Hao et al., 2019). Automated

feedback mostly provides information on errors in codes and not on underlying concepts of those errors (Keuning et al., 2019). Automated feedback does not provide any insight on eliminating the problem that is found in code, nor does it suggest next steps in learning, which makes it is difficult for students to proceed with appropriate learning strategies.
Such limitations of Computer Science learning environment lead to students' developing inaccurate judgements about effectiveness of certain learning strategies. As a result, students often engage into ineffective learning strategies while considering such strategies effective, which is detrimental to students' learning in the long run (Cervin-Ellqvist et al., 2020).

The use of ineffective learning strategies might stem from the fact that such learning strategies are easy to use (Wissman et al., 2012) or because students wrongly assume such strategies to be effective (Cervin-Ellqvist et al., 2020). However, in the context of our study, Computer Science students in large classes during the transition period, how students perceive instructional feedback and how those feedback perceptions translate into students' motivation and students' use of learning strategies is still largely unstudied. The lack of broader studies on feedback perceptions amongst students is challenging, because we do not know to what extend do feedback perceptions influence what learning strategies students use. Several scholars examined learning strategies in conjunction with performance of students in STEM courses (Lawanto & Santoso, 2012; Grohs et al., 2018; Meyer et al., 2015; Litzinger et al., 2010), however Computer Science students' use of learning strategies and aspects of motivation in conjunction with instructional feedback perceptions has yet to be investigated.

The purpose of this study was twofold: the primary goal was to explore what feedback perceptions do undergraduate students of Computer Science have when entering University learning environment; the secondary purpose of this study was to better understand how students use instructional feedback that is provided to them: what aspects of motivation do students report to play role in students' willingness to engage with instructional feedback;

and what learning strategies do students use subsequently to apply this instructional feedback.

With this study we address a gap in understanding how students of large classes in Computer Science use instructional feedback. With the help of quantitative and qualitative data, this paper aims on creating the 'holistic', comprehensive picture on how students perceive instructional feedback, what motivation students have in response to those feedback perceptions and what learning strategies students use to apply instructional feedback.

In particular this paper addresses following research questions:
(RQ1) How do students of large classes in Computer Science program perceive instructional feedback?
(RQ2) What motivation and learning strategies do students of large classes in Computer Science program report for applying the instructional feedback they receive?

4.3. Method

4.3.1. Participants and setting

The study was conducted in 2020 with undergraduate Computer Science students at a leading technological university in the Netherlands. For this study we selected programming course that belonged to Computer Science program, because programming is the core of Computer Science education, and because according to many studies, programming is the main course where students often struggle with learning (Keuning et al., 2019; Falkner et al., 2014; Jenkins, 2002). Admission to bachelor's level requires completion of certain STEM courses, for example, mathematics and physics, in upper secondary school. Selection is based on average grades and on pre-university exam conducted by the university itself.

The Programming course was a combination of traditional on-campus course with lectures and written exams; and lab projects where students work on coding assignments

independently under the supervision of several teaching assistants in case students need help. Two types of learning environments ensured variation of responses reported by students. In total, there were slightly over 500 students in the cohort of 2020 for Computer Science program.

4.3.2 Research design

Our goal was to collect essential data on students' feedback perceptions, students' motivation and students' learning strategies in authentic learning environment, which was a large programming class. For that purpose, our study adopted a concurrent mixed-method design (Driscoll et al., 2007), involving qualitative and quantitative data collection through questionnaire and interviews. We collected all quantitative and qualitative data simultaneously during the first semester. In the first semester, students learn the basics of programming, testing and developing a software application. It is a relevant time to measure students' feedback perceptions and explore students' motivation and what learning strategies students use, since in the first semester students are fully immersed in their new learning environment and have little time to evaluate or reflect on their experiences. In other words, in the beginning of student's first year, students' impressions are still fresh.

4.3.3. Data collection instruments

a) Quantitative data collection

We used a modified version of the Instructional Feedback Orientation Scale (IFOS) by King et al. (2009) and the Motivated Strategies for Learning Questionnaire (MSLQ) by McKeachie et al. (1986).

MSLQ is a standardized, validated and normed tool to assess students' motivation and learning strategies. The MSLQ is the most common qualitative data collection instrument to evaluate students' motivation and students' use of learning strategies (Turner, 1995; Pintrich et al., 1991; Winne & Perry, 2000). MSLQ includes two main categories: (1) Motivation category, that assesses students' goals, beliefs of their own skills and competences,

students' perceived value of the program, fears and doubts regarding learning and assessment; and (2) Learning Strategies category, that assesses students' use of various learning strategies (Appendix C).

Each category of the MSLQ consists of statements that students rate on a 7-point Likert scale according to their level of agreement. We were able to adjust a scale to a 6-point Likert scale without influencing the process of data collection. Adjusting the scale allowed us to remove "neutral' option to force students to choose an answer; and it allowed us to align with the IFOS questionnaire which had a 6-point Likert scale.

The IFOS is a validated, normed and standardized tool used to explore what perceptions and attitudes towards feedback students have (King et al., 2009). The IFOS explores four feedback dimensions: (a) Feedback utility, which pertains to the perceived usefulness of feedback according to students; (b) Feedback sensitivity, which assesses students' emotional or attributional sensitivity to instructional feedback; (c) Feedback confidentiality, which pertains to the students' preferences in either public or private context when receiving instructional feedback; (d) Feedback retention, which reports on students' ability to recognize, accept, remember and recall the instructional feedback provided to them (Appendix D).

We provided respondents with the following answer options: very untrue of me='1'; untrue of me='2'; somewhat untrue of me='3'; somewhat true of me='4'; true of me='5'; very true of me='6'.

Final version of the questionnaire consisted of three parts:

1. 5 questions related to student demographics to check whether respondents' demographics represent the total population.
2. 81 statements of the MSLQ exploring students' motivation for learning and students' learning strategies.
3. 27 statements of the IFOS exploring students' feedback perceptions.

The administration time of the entire questionnaire was approximately 30 minutes.

b) Qualitative data collection

To collect qualitative data about students' feedback perceptions, students' motivation and students' use of learning strategies we chose semi-structured group interviews. Semi-structured interviews give more flexibility for researchers to interact with students compared to structured interviews (Park, 2000), therefore we were able to get more information from students regarding feedback, motivation and experiences with learning strategies. Additionally, group interviews focus on a main theme while lowering the risk of such phenomenon as 'group think', and provide participants with time to think, reflect and discuss their answers with fellow students (Gubrium & Holstein, 1997, 1998; Fusch et al., 2022). Krueger and Casey (2015) found that group interviews are beneficial when it is necessary to capture the dynamic of interactions within the group in authentic, natural environment.

Interviews were conducted three times during the semester: in the beginning, in the middle and in the end to track changes in students' attitudes towards feedback, students' motivation and learning strategies.

In total, 17 undergraduate students of Computer Science program participated in all three rounds of interviews. By doing interviews with the same students three times during the first semester, we attempted to capture the full experience from beginning of the coursework till the first final exams. Interviews pertained to the same topics every time, although we slightly adjusted the questions for students to be able to reflect on their progress. In total, we held 11 interviews in the first round; 6 interviews in the second round and 3 interviews in the third round. Interviews were organized during lunch breaks and students were offered free lunch for their participation. Interviews ranged from 30 minutes to 60 minutes.

4.3.4. Data analysis

Triangulation is the process when different methods are used to examine the problem with the purpose to create a complete picture (O'Cathain et al., 2010). The triangulation of qualitative and quantitative data has been recognized as a valuable approach to mixed methods research, as it allows for the validation and complementarity of the findings (Johnson et al., 2020; Creswell & Clark, 2018). Relying on suggestions by Creswell (2009) and Clark et al. (2003), we used a triangulation design with parallel mixed-method approach as it allows us to develop a richer perspective of the students' feedback perceptions, motivation and student's learning strategies in the large class during the first semester of the Computer Science program.

Qualitative and quantitative data was analysed separately first, to produce two sets of findings. Those two sets of findings are then compared to see similarities and differences. Triangulating our results allowed us to obtain a more complete understanding from two databases (Morse, 1991). We present our results in narrative that includes subsets of both quantitative and qualitative results – also known as cross-case comparison (Caracelli & Greene, 1993; Creamer, 2018). According to Creamer (2018), cross-case comparison does not only provide us with a 'holistic, internally coherent profiles' (p. 104), it also allows us to visualize connections of the qualitative and quantitative results. Both types of data have equal value in this study. The results of the triangulation process take place in interpretation process and are presented in the **Discussion** section of this study.

a) Quantitative data analysis

SPSS quantitative analysis software version 26 was used to analyse the quantitative data. First, the data was cleaned and organized. We removed outliers for age (mean age=18.79; SD=1.06). Second, to maintain confidentiality of all participants any identifying information was removed from the dataset. All variables were checked for missing values. Although the entire data set had 3.1 per cent missing cases, the T-test did not show any particular pattern

to the missing items (Musil et al., 2002). Statements from MSLQ and IFOS that were phrased in reverse were reverse coded for the analysis.

We analysed the MSLQ and the IFOS separately, and although both instruments are validated, standardized and normed, we run the exploratory factor analysis with eigenvalues set at >1 and varimax rotation to examine the structure of the questionnaire and Cronbach's alpha to check the internal consistency of the scales of each instrument. Together with factor analysis we ran the Kaiser-Meyer-Olkin (KMO) test on the final dataset to evaluate the adequacy of a sample size (Field, 2009). The MSLQ scales had a KMO value of 0.57, which is considered as satisfactory to proceed as it exceeds the minimum value of 0.5 (Kaiser & Rice, 1974). The IFOS scales had a KMO value of 0.81, which indicates excellent sample size (Kaiser & Rice, 1974).

The table with the Cronbach's alpha values is presented in Appendix G. All scales with Cronbach's alpha values below 0.7 were removed from further analysis (as suggested by Field, 2009). Two of the removed scales represented two learning strategies: Peer learning and Help seeking. We will touch on this in the **Discussion** section. Descriptive statistics with mean, median and standard deviation for the MSLQ scales and per item per sub-scale, and for the IFOS scales and per item per sub-scale are presented in Appendix F and Appendix E correspondingly.

b) Qualitative Data Analysis

For the analysis all interviews were transcribed verbatim and analysed manually. Transcripts were analysed using the ATLAS.Ti qualitative analysis software package. All identifying information was removed from the transcripts prior analysis to maintain confidentiality of the respondents.

First, the author who had collected the data read all the transcripts of all interview rounds, simultaneously coding using inductive thematic analysis (Braun & Clarke, 2006). The main

codes were derived from dimensions of IFOS and the scales of MSLQ. Fragments containing information on students' feedback perceptions were coded with four dimensions of IFOS: Feedback Utility, Feedback Confidentiality, Feedback Sensitivity and Feedback Retention. Fragments, containing information of students' motivation and learning strategies were coded by the subscales of MSLQ correspondingly. During the third step, these codes with fragments of text were reviewed by other members of the research team, to ensure that the first author's stances towards codes are consistent throughout the entire coding process. The final step included evaluating appeared patterns and interpretations of the results by means of triangulation.

4.3.5. Human Research Ethics

This study was approved under the requirements of Human Research Ethics Committee of Delft University of Technology. Approved Case number 995. All participants were required to sign an informed consent for both data collection events. All students participated in this study voluntarily. No member of a research team had any involvement in teaching or supervising any Computer Science students in any capacity. None of the research team members had any formal relation with the program of Computer Science of any other affiliations within the department of Computer Science and/or faculty of Electrical Engineering, Mathematics and Computer Science at Delft University of Technology.

4.4. Results

(RQ1) How do students of large classes in Computer Science program perceive instructional feedback?

4.4.1. Quantitative results

For convenience, students' responses on Likert scales were transformed into numbers from 1 to 6, where 1 is equal to 'not at all true of me' and 6 is equal to 'very true of me'. Then, we obtained mean, median and standard deviation for each statement from the IFOS questionnaire. Appendix E contains a table with means, standard deviations and median

scores on each statement in each dimension from the IFOS. Following table presents students' responses for each of the four IFOS dimensions.

Table 3.1. Students' reported feedback perceptions

	Mean	Standard Deviation	Median
Feedback Utility	4.81	0.769	5.00
Feedback Sensitivity	2.88	0.647	3.00
Feedback Confidentiality	3.69	1.064	4.00
Feedback Retention	2.71	0.973	3.00

The **Table 3.1.** shows that students score two dimensions of instructional feedback the highest: (1) Feedback utility, that measures perceived usefulness of instructional feedback according to students; and (2) Feedback Confidentiality, measuring students' preference to receive feedback publicly or privately. High scores in those dimensions indicate that students perceive instructional feedback as valuable and that there is a preference to receive feedback privately. At the same time, low scores in the dimensions Feedback Sensitivity and Feedback Retention indicate that students' feelings are not hurt by instructional feedback and students do not have problems recognizing, accepting and recalling instructional feedback. However, it is important to see students' responses in each of the dimensions to see the details in how instructional feedback is perceived.

When going to item-to-item level, students in our population report instructional feedback as a waste of time (mean 5.23, standard deviation = 0.979, median = 5.00, where 5 = 'true of me'. This statement was reported by our students the most. However, instructional feedback is also seen as a potentially valuable form of praise or reward from their instructors (mean 4.81, standard deviation 0.981, median 5.00 where 5=true of me).

Students do not perceive corrective feedback as embarrassing or intimidating (mean 2.66, standard deviation = 1.337, median = 2.00 where 2 = untrue of me) and (mean 2.19, standard deviation = 1.217, median = 2.00 where 2 = untrue of me), respectively.

Nevertheless, students find it challenging to cope with corrective feedback (mean 4.99, standard deviation = 1.087, median = 5.00 where 5 = true of me).

Students in our population prefer to receive instructional feedback privately (4.26, standard deviation = 1.342, median = 4.00 where 4 = somewhat true of me). Since all items in Feedback Retention are reverse-coded, low scores in this dimension show that students are able to recognize, accept and recall instructional feedback they receive. In our population students had reported low scores for Feedback Retention dimension, for example, for statement 'I can't remember what instructors want me to do when they provide feedback' (mean 2.56, standard deviation = 1.070, median = 2.00 where 2 = untrue of me).

4.4.2. Qualitative results

During the first round of interviews, students primarily focused on feedback utility, or perceived feedback usefulness. Students perceived usefulness of feedback was mentioned in conjunction with aspects of learning environment and the influence of instructional feedback on the process of learning itself.

Students mentioned that feedback usefulness is related to two aspects of the learning environment: (1) perceived value of the instructors; and (2) perceived value of the course itself. According to students' opinions, university instructors are seen as more constructive compared to secondary education teachers, therefore, instructional feedback provided by university lecturers were perceived as more constructive and therefore valuable, compared to feedback provided in secondary education.

Perceived value of various courses within the Computer Science program was discussed by students in relation to whether or not instructional feedback will be used or ignored. Programming course was seen by students as more valuable compared to other introductory courses of Computer Science program, for example, Computer Organization course, which was perceived by students as less valuable.

Students' perceived usefulness of instructional feedback was also mentioned in conjunction with the process of learning itself, in particular – what benefit does instructional feedback bring to students' learning. Students in the groups argued that instructional feedback is only if it is tangible and contains a reward for learning. Passing an exam without the grade was also considered sufficient instructional feedback. Students also reported corrective feedback to be seen as offensive and of the less value compared to positive feedback, which increased students' confidence in learning the course concepts. Receiving corrective feedback was perceived as negative experience with instructional feedback. Students added that corrective instructional feedback often focused on explaining the grade assigned rather that offered directions for further improvements. Students' often mentioned question: 'Why do I have 8 instead of 10?' exemplifies students' confusion that was shared during the interviews.

While intended to be discussed, formative feedback was rarely mentioned by students in our groups: students did not perceive formative feedback as valuable, since they were convinced that value must be tangible – a grade, a mark of even 'pass' or 'fail' students perceived as more valuable than any type of formative feedback as students did not believe such feedback actually has influence on learning and quote: 'will most likely be ignored'.

RQ2. What motivation and learning strategies do students of large classes in Computer Science program report for applying the instructional feedback they receive?

a) Quantitative results

Descriptive statistics, including mean, standard deviation, and median, are provided in **Table 3.2.** in for each sub-scale of the MSLQ, and in Appendix F on each item in each sub-scale of the MSLQ. The table is organized according to two main categories: students' motivation and students' learning strategies. Following results represent students' motivation and learning strategies in the beginning of the first semester.

Table 3.2. Students' reported Motivation and Learning Strategies

	Mean	Standard Deviation	Median
Motivation Category			
Value Component: Intrinsic Goal Orientation	4.43	0.797	5.00
Value Component: Extrinsic Goal Orientation	4.00	0.888	4.00
Value Component: Task Value	4.67	0.821	5.00
Expectancy Component: Control of Learning Beliefs	4.90	0.743	5.00
Expectancy Component: Self-Efficacy for Learning and Performance	4.29	0.820	4.00
Affective Component: Test Anxiety	3.60	1.032	4.00
Learning Strategies Category			
Cognitive and Metacognitive Strategies: Rehearsal	3.38	1.065	3.00
Cognitive and Metacognitive Strategies: Elaboration	4.26	0.756	4.00
Cognitive and Metacognitive Strategies: Organization	3.60	1.095	4.00
Cognitive and Metacognitive Strategies: Critical Thinking	3.68	0.852	4.00
Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation	3.89	0.600	4.00
Resource Management: Time and Study Environment	4.00	0.804	5.00
Resource Management: Effort Regulation	4.10	0.926	4.00
Resource Management: Peer Learning	3.50	1.055	4.00
Resource Management: Help Seeking	3.35	0.930	3.00

The Motivation Category reports on students' motivation using several validated scales including intrinsic and extrinsic goal orientation, learning beliefs, self-efficacy, task value, and test anxiety. Such sub-scales of Motivation Category as Control of Learning Beliefs and Task Value were reported by students as the highest. High scores in these sub-scales indicate that students have strong confidence in their own abilities to learn successfully and that students see the programming course as valuable. Results indicated high levels of self-efficacy for learning and performance, with participants reporting confidence in their ability

to understand basic concepts taught in the course (mean=5.19, standard deviation=0.802, median=5.00). Additionally with the belief that they can learn the course material through appropriate study methods (mean=5.16, standard deviation=0.773, median=5.00). Intrinsic motivation was also reported high, indicating the preference amongst the students for material that arouses their curiosity even if it is difficult to learn (mean=4.69, standard deviation=1.082, median=5.00).

The Learning Strategies Category consists of nine dimensions that reflect the various approaches students use to learn. Under the Learning Strategies Category, all strategies are divided into two dimensions: Cognitive and Metacognitive Strategies, which involve the ways students regulate and evaluate their learning process, and Recourse Management, which regulates internal and external resources. In the present study, Elaboration (mean 4.68, standard deviation 1.082, median 5.00 where 5=true of me) and Metacognitive Self-Regulation (mean 4.85, standard deviation 0.722, median 5.00 where 5=true of me) were reported as the highest scoring learning strategies by students. Conversely, low scores were reported in Organization (mean 3.36, standard deviation 1.540, median 4.00 where 4=somewhat true of me), Critical Thinking (mean 4.11, standard deviation 1.222, median 4.00 where 4=somewhat true of me), and Rehearsal (mean 3.88, standard deviation 1.400, median 3.00 where 3=somewhat untrue of me), indicating that students struggled with organizing and applying new knowledge, reflecting on it, and remembering it. The item "When course work is difficult, I either give up or only study the easy parts" scored relatively high (mean 4.39, standard deviation 1.274, median 5.00 where 5=true of me), indicating a tendency to avoid challenging coursework. Regular attendance of the course was the highest scoring item in the planning and scheduling dimension (mean 4.72, standard deviation 1.554, median 5.00 where 5=true of me). Compared to the Motivation Category and IFOS items, students in our sample were more hesitant to assign high scores to the Learning Strategies Category.

b) Qualitative results

During the interviews, students focused mainly on experiences learning in the new environment and process of learning itself. In the first interviews, students demonstrated intrinsic motivation and confidence in their own abilities. Students do not know how to approach learning in particular, but they have strong beliefs that with right effort and motivation they will be able to achieve their learning goals. Students discussed difficulties and challenges asking questions from instructors, peers and teaching assistants. Students claimed that their relationship with the instructor significantly influenced their motivation to ask questions, and since students did not have personal connection with instructors, students showed inhibition to help seeking. According to students, there was no space nor time to think, ask questions or pause during lectures – it stops the flow of the lecture, and students felt that instructors do not support asking questions during lectures. Another striking remark from students was the wide diversity of background knowledge in the class: students felt uncomfortable and judged by more knowledgeable fellow students when asking questions during the lectures. According to students themselves, unwanted attention from fellow students is one of the reasons students resist to seek for help even if students are stuck or struggling.

Students expressed concerns about using ineffective learning strategies and how it impacts students' motivation and increases students' anxiety. Students who experienced difficulties using effective learning strategy experienced feeling lost and unsure about how to approach course material and assignments, leading to anxiety about the future success. Students reported that the inability to choose learning strategies was associated with both time and study environment management and effort regulation. Students struggled scheduling appropriate time for learning and sticking to those plans. Moreover, according to students themselves, the learning process was poorly structured and difficult to follow. Students shared an opinion that poorly structured course materials is the result of highly paced lectures and heavily loaded curriculum.

Although we do not have quantitative data supporting findings of the second and third round of interviews, we believe that it is important to mention the drastic changes in

students' experiences and opinions during second and third rounds of the interviews. By the third round of interviews, students' motivation becomes highly extrinsic, with several students mentioning that high salaries in IT sector is the only motivation that keeps students continuing studying.

Apart from that, students mentioned issues related to maintaining concentration in large class learning environment. Students perceived whole-class lectures as a conference rather than learning environment. Students did not feel that they are a part of the learning process. Students reported that the value of the lectures decreased dramatically with fellow students not coming to the lectures and preferring to study at home or use Collegerama (online learning platform with recorded lectures). Students themselves attributed decreased value of the lectures to the perceived lack of support and guidance from instructors. During the second and third rounds of interviews, students shared that large learning environment provides limited possibilities to create meaningful connections with fellow students and instructors. Students shared that lack of socializing and personal connections with fellow students and instructors resulted in many students not coming to the lectures and studying at home via Collegerama.

4.5. Discussion

4.5.1. Discussion and conclusion

The aim of this study was two-fold: (1) to investigate how first-year undergraduate students perceive instructional feedback; and (2) to investigate what motivation and what learning strategies students exhibit to apply instructional feedback. We also take into account the complex context of this study: large class of Computer Science program during the first semester.

A broader picture was achieved by triangulating the data: both quantitative and qualitative data collection and analysis. Results from both data showed us a mixed picture: students see instructional feedback as valuable, however, the instructional feedback is seen as a form

of praise, a reward for students' learning. Students in our population scored highest the statement that encapsulated instructional feedback as 'a waste of time', which might indicate that students do not use instructional feedback. It is not yet clear why students reported such contradicting results, however, Winstone et al. (2017) derived results showing that although students find feedback important, its use is often limited due to students' difficulties decoding instructional feedback, applying instructional feedback and expanding effort to improve when needed.

When asked to elaborate on feedback during group interviews, students shared that feedback at the university is seen as 'more constructive' compared to feedback students received in secondary school. These feedback perceptions might be partially responsible for seeing feedback as valuable, since according to students, the instructors at the university are seen as 'more constructive' compared to instructors at secondary school. This perception of instructors at the university and the instructional feedback that they provide indicates that students indeed perceive feedback as valuable during their study at the university: students claimed that constructive feedback is most likely to be used as it aims towards improvement, while non-constructive feedback will most likely be ignored.

At the same time, students concluded that whether feedback will be used or ignored also depends on how important certain module in the taught program is. In our population students have certain perceptions regarding instructors and the value of the program and according to students these aspects influence instructional feedback application. These findings compliment the results obtained by van der Kleij et al. (2015), who argued that whether feedback is to be applied or ignored depends on what feedback perceptions do students have. Similar findings are elaborated by Handley et al., 2011, stating that students' motivation to engage with instructional feedback leads towards certain perceptions of such feedback. For our population we see that students see instructional feedback important because students demonstrate high self-efficacy and self-beliefs together with high intrinsic motivation to engage in programming course.

However, as mentioned before, instructional feedback is only important to students when it is tangible – in the form of grades or 'pass' on tasks, assignments and exams. In the questionnaire, students score highest on statement that describes instructional feedback being a valuable form of praise and reward from instructors. Students perceive instructional feedback not as a tool to improve learning, but rather as an assessment of students' cognitive abilities. This perception of instructional feedback partially explains high scored for Feedback Confidentiality dimension: corrective feedback is seen as offensive. Similar scores are reported to items from Feedback Sensitivity dimension: students reported that it is difficult to 'get over' corrective feedback. High scores in these scales compliment findings of Dweck et al. (1995) and Black and William (1998) that argue that external feedback results in students seeing feedback as a final judgement of one's personal skills and competences rather than an instrument to improve skills and knowledge. The same results are shared in the studies of Boud and Falchikov (2007) and Boud et al. (2018), who claimed that due to unrealistic expectations of the University on undergraduate students during transition period, feedback is seen as a judgement of personal mental abilities, rather as a reflection on gaps in knowledge and a tool for improvement.

Regarding motivation, students in our population reported high following scales: (1) Self-Efficacy for Learning and Performance; (2) Control of Learning Beliefs and (3) Task Value. Students reported high scores in statements that concluded students' confidence in ability to learn difficult concepts in the program. In the questionnaire, students report on importance to learn course materials and high preference in material that arouses curiosity, even when material itself is difficult. Similarly, during the first round of interviews students claimed to be highly motivated to learn and they were confident in their own cognitive abilities to understand the concepts taught in the program. However, students also shared concerns regarding inability to use effective learning strategy due to lack of experience, lack of guidance from instructors and lack of support. As a result, students complained that not

knowing how to pursue learning influences their motivation and increases anxiety, fears and worries about the exam performance.

By the third round of interviews students share that they feel highly extrinsically motivated claiming that the only motivation for them to continue their study is high salaries amongst the IT workers in the Netherlands. Unfortunately, we did not administer the questionnaire in the same period when collecting qualitative data from the third round of interviews, which we will mention as a suggestion in **Future directions** section.

Students' difficulties choosing productive learning strategies were also highly present in Learning Strategies category part of the questionnaire. Questionnaire results showed lowest scores reported by students amongst the learning strategies that aimed on organizing and applying new knowledge. On the contrary, highest scores amongst students in our population were given to the items within the learning strategy category that reported regular attendance of the lectures. Results from the questionnaire showed that students tend to avoid course work when it becomes difficult. Dunlosky and Rawson (2015) mentioned that during the first semester some learning strategies might be more effective to students, compared to the effectiveness those strategies (see **Table 1.1** in **Chapter 1** of this thesis). However, students shared an overall confusion about using effective learning strategies for instructional feedback application, therefore it is safe to conclude that students use low-utility learning strategies partially due to the reasons explained in the introduction part: (a) easy to use; (b) inaccurate judgements of effectiveness of such strategies; (c) prior experience with such strategies. Such learning strategies as, for example, Help Seeking and Peer Learning got lowest scores amongst the students in our population. During the interviews students partially elaborated on issues influencing low utility of these learning strategies: lack of relationships with instructors was mentioned as the reason to not engage in learning strategies that encourage searching for assistance externally. Students also mentioned that due to a wide distribution of prior education in a large class, inhibition to ask questions is related to unwanted attention from fellow students. These

findings compliment results of Mulryan-Kyne (2010) that argues that large classes, and lack of meaningful interactions between students and instructors in particular results in students feeling anonymous, which influences students' sense of responsibility and increases students' reluctance and withdrawal from in-class activities and learning (Ford-Eickhoff & Kane, 2019). Since students are not explicitly educated how to learn effectively, especially in the specific learning environment that is not common to students – large class – students struggle choosing learning strategies that would help to achieve students' personal learning outcomes. Despite struggling to resolve how to learn productively, students still resist asking questions and search for help as they believe that no one will assist them. Students shared that lectures contain heavy load of information and little to no opportunity to ask questions or create meaningful connections with instructors or fellow students. As a result, students feel uncomfortable to interrupt 'the flow' of the lecture which contributes to students feeling detached from learning process.

Overall, this study shows that although students value instructional feedback and are highly motivated to learn, are confident they can learn [reported before the first exams] and value the programming course highly, students report experiencing difficulties when applying instructional feedback to improve learning. Students demonstrate use of low-utility learning strategies aimed on attending the lectures regularly, while effective learning strategies are neglected. Such results suggest low metacognitive awareness of students in effective learning strategies and highlights importance of educating students about how to apply instructional feedback to learn effectively.

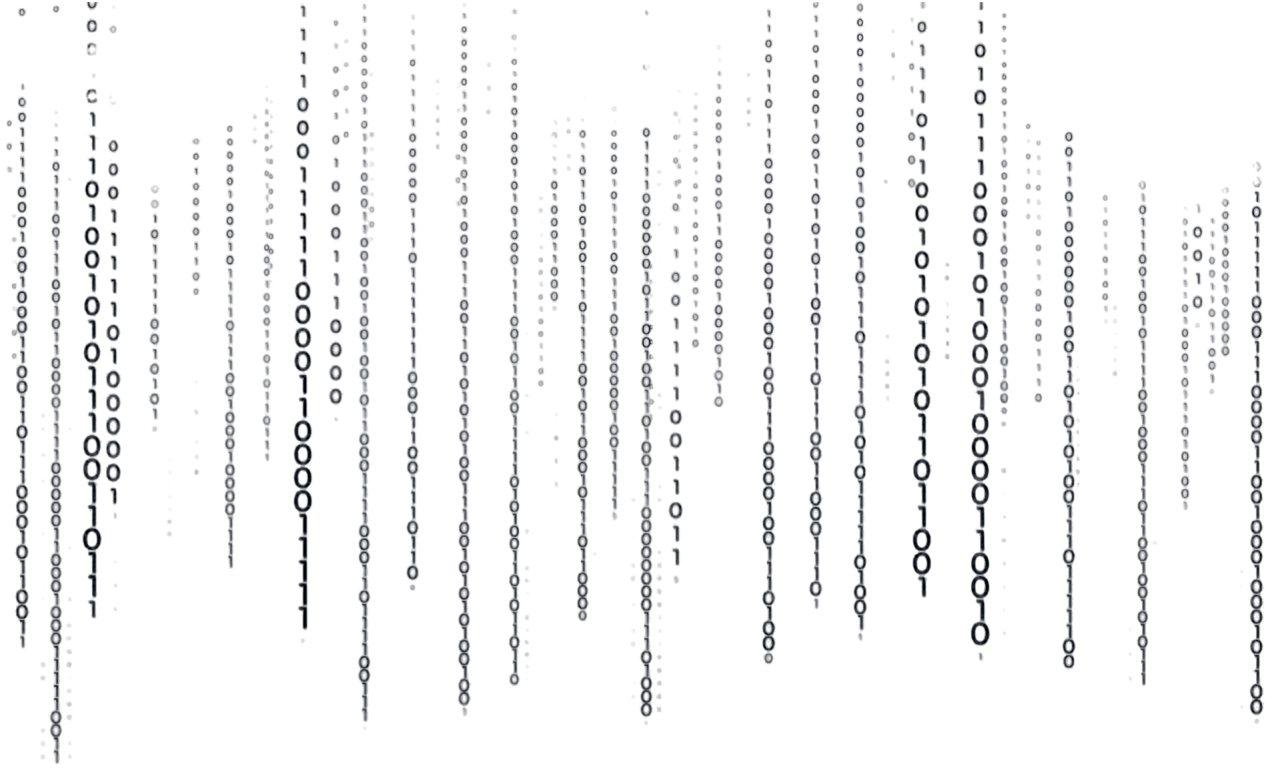
4.5.2. Limitations and future directions for research

The results of our study should be interpreted with some limitations in mind. First, we used self-report data from questionnaire and interpretations from students' group interviews. Second, we consider the main limitation of this study is the sample size. Due to the small sample size, we cannot generalize our findings beyond this sample. These results may be potentially influential in terms of quality of instructor-provided feedback practices once the

results are substantiated by other measurement instruments. Third, the length of the questionnaire might have caused survey fatigue and low responses, that are common amongst questionnaires and surveys that take longer than 15 minutes to complete (Porter et al., 2004). Fourth, we adjusted the Likert scales to a six-point scale, which might have influences item variance. Finally, our study might have been influenced by volunteer bias.
We collected data about gender to provide as background information, however, we did not aim to compare across gender as, for example, Karpicke et al. (2009). This could be addressed in future study.

Additionally, there are several limitations related to collecting and analysing qualitative data. Interviews often involve a small sample size and lack generalizability due to their exploratory nature (Creswell & Creswell, 2018). Additionally, there may be issues related to the validity and reliability of the findings, as well as the transferability of the results to different contexts (Creswell & Creswell, 2018; Morse, 2015; Braun & Clarke, 2019).

Even though our data provides evidence for validity, other measuring instruments, such as, for example observations, could substantiate our results even further. Given the constant interest in improving and facilitating learning in the classroom with regards to feedback practices, understanding how students perceive feedback and how they use it could potentially support promoting effective learning strategies. According to Pat-El et al. (2013), not utilizing the feedback provided by instructors result in failed learning and failed accountability of the students. Therefore, it is important not to only reflect on the information from this study, but to use its findings to explore further what exactly do students do with instructional feedback. Potentially, appropriate feedback interventions could be designed, implemented and evaluated to improve the quality of instructors' feedback in order to support students in using effective learning strategy for instructional feedback application.



Chapter 5. Facilitating learning in Computer Science education

Instructors' feedback perceptions and feedback practices in large classes

This chapter has been submitted to Australasian Journal of Engineering Education in adapted form as:

van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. Facilitating learning in Computer Science education: Instructors' feedback perceptions and feedback practices in large classes.

5.1. Introduction

Rapid development of the Computer Science education field poses many educational and pedagogical challenges for Computer Science educators, such as, for example, recruitment of well-prepared instructors, support for Computer Science instructors' ongoing professional development and teaching-related issues, for example, design of appropriate instructional teaching and assessment (Stephenson et al., 2005). As stated by Tucker et al. (2007), Computer Science teachers are required to not only master the knowledge and skills of a subject matter, but also obtain pedagogical skills that facilitate learning in their classrooms. The mastery in subject matter and pedagogical skills is not unique to Computer Science education, and also true to other fields, for example Engineering, Law or Medicine. However, Computer Science education stands out from other fields for its major focus on development of the computational thinking by introducing various programming paradigms to students early in their studies (Wing, 2006). Programming paradigms do not only emphasize learning to program or learning a programming language syntax, but also the development of students' computational thinking which is one of the core skills to master in Computer Science learning (Tucker & Noonan, 2002; Van Roy & Haridi, 2004; Wing, 2006). Computational thinking is a cognitive ability that involves skills in step-by-step problem-solving by means of designing solutions to be implemented and replicated by people, computers or both (Papert, 1980; Wing, 2011, 2014). Computational thinking requires students to be able to demonstrate: 1) strong cognitive skills, for example, divide problem into sub-problems, think abstractly and be able to generalize (Wing, 2006; Cuny et al., 2010); 2) working skills in design and development of visual characters; and 3) social skills, for example independent learning, teamwork and time management (Ragonis & Hazzan, 2019; Günbatar, 2019). Successful development of such skills amongst students requires the instructors themselves to demonstrate broad, transdisciplinary knowledge and skills that are to be applied in various contexts (Ragonis & Hazzan, 2019). However, more and more studies on teaching Computer Science conclude that often instructors in Computer Science education are not adequately prepared to teach (Gal-Ezer & Harel, 1998; Ni, 2009), lack pedagogical skills and knowledge (Denning, 2017; Won Hur, 2019; Shulman, 1986; Hazzan

et al., 2020), and find it challenging to adapt pedagogical competences to their unique learning environment conditions (Hazzan & Ragonis, 2014; Haberman & Ragonis, 2010; Shulman, 1986; de Raadt et al., 2004).

5.1.1. **The case of Delft University of Technology**

To prepare Computer Science instructors to teach successfully and to facilitate learning in their classrooms, Delft University of Technology introduced the University Teaching Qualification course with a duration of total 160 hours including 4 hours of homework per week (University Teaching Qualification, 2023). Overall duration is assumed to be between 7 and 12 weeks. University Teaching Qualification course includes four major topics: 1) Development; 2) Teaching; 3) Assessment; and 4) Supervision. This program is compulsory for all new members of the Delft University of Technology with less than 5 years of teaching experience. The University Teaching Qualification course covers the basic principles of teaching duties introducing various teaching tools, which, however, imply that the competences obtained in this program still need to be adjusted to fit specific conditions of the learning environment to facilitate learning amongst students. The conditions of the learning environment of Computer Science program are similar to other engineering disciplines across the Delft University of Technology, for example, a heavily scaffolded curriculum and high pace of lectures (Zhao et al., 2018; Van der Hulst & Jansen, 2002). However, the recent rapid growth in student numbers in Computer Science classes became an issue for the teaching community of Computer Science who were not adequately prepared for such a fast change.

Increasing class sizes are not unique to the Netherlands – as growth in student numbers is common in mass education systems around the world (Gibbs and Jenkins, 1992). However, teaching and learning in large classes are generally seen as extra challenging amongst scholars and educators (Ake-Little et al., 2020; Diette & Raghav, 2015; Allais, 2014). Although the challenge of a ‘large class’ is rather varied to the discipline, pedagogical approaches, facilities and the resources of the learning environment, we refer to the definition of a large

class by Hornsby et al. (2013:8): "[large class is a] …learning environment where the quality of student learning may be impacted, negatively, by the number of students in the class". Teaching large classes requires educators to adjust and modify the established pedagogy, which is often designed and tested in much smaller learning environments, to meet the needs of students in the new context (Cohen-Vogel et al., 2015; Fishman et al., 2014; Honig, 2006). Scaling-up educational innovations is a well-known challenge for educators and scholars, because the success of implementation of the new, innovative approaches relies not only on scientific evidence, but rather on various factors, such as, for example: 1) expertise of educators, 2) opportunities to collaborate with other people involved in implementation; 3) conditions of the learning environment, and 4) the resources available (McLaughlin, 1991; Anderson et al., 1987; Cannata & Nguyen, 2020). As a result, the quality of teaching and learning in large groups might be compromised, especially when educators do not have sufficient training and experience (Boud & Molloy, 2012). Broadbent et al. (2017) argue that apart from mastering the content, large classes require competence in design, management and standardization of feedback practices.

In the case of Delft University of Technology, instructors use knowledge they gain from the assessment course from the University Teaching Qualification to create assessment practices to evaluate students' knowledge on tasks, assignments and exams. However, instructors themselves are not involved in providing feedback to students. Because of the large number of students in a class, teaching assistants are the primary source of feedback to students. Teaching assistants are usually second-year students of the same program as first-year undergraduates. Teaching assistants have a flexible work schedule that allows them to follow their own study program and to assist first-year undergraduates. During the moment of collecting data in 2018, teaching assistants were not required to complete the University Teaching Qualification program which implies that teaching assistants often lacked basic pedagogical skills and knowledge that instructors were required to obtain. This study is set within the programming course of Computer Science program, where feedback

is provided by teaching assistants orally or in the form of grades for the exams with or without written comments.

5.1.2. Feedback in facilitating learning

The importance of feedback practices has been one of the main focuses of scholars and educators for many decades (Nicol & Macfarlane-Dick, 2006; Dawson et al., 2019; Hattie & Timpereley, 2007; Carless & Boud, 2018; Boud & Falchikov, 2007). Hattie and Timpereley (2007) claim that feedback is one of the core components in students learning which has a crucial influence not only on quality of learning, yet also on the students' learning experience. This claim implies that the quality of instructional feedback is a crucial determinant of students' learning and study success. Because feedback has a large influence on student learning, it is important to understand what criteria contribute to the quality of feedback and how to best deliver it. Students in higher education are expected to be able to study independently, which includes organizing their learning process and using feedback to improve learning (Leese, 2010; Bjork et al., 2013; Toa et al., 2000). These expectations are reflected in the feedback practices that often focuses on evaluation and certification of knowledge, rather than focusing on in-process improvement of learning (Beaumont et al., 2011; Boud & Winstone, 2020). In Computer Science education students often obtain skills in computational thinking by means of programming, which is a core subject (Jenkins, 2002). However, feedback in programming is mostly automated, ranging from feedback on errors in codes to providing explanations of the logic behind those errors to certain extend - as opposed to personalised and individually tailor feedback (Keuning et al., 2019).

Many scholars who focus on quality of feedback and its influence on students' learning have devoted their careers to understand feedback and explore the criteria of feedback practices that facilitate learning in the classroom (Boud & Falchikov, 2007; Henderson et al., 2019; Dawson et al., 2019; Chan & Luo, 2021). Their efforts resulted in abundance of guidelines, policies and practical advice to improve the quality of instructional feedback in many different contexts and learning environments (Boud et al., 2018; Henderson et al., 2019;

Ferguson, 2011; Poulos & Mahony, 2008; Nicol & Macfarlane-Dick, 2006). Despite the large body of knowledge and the best efforts of educators, students retain a passive role in the learning process: students fail to recognize feedback, do not know how to apply feedback for improved learning or ignore the feedback altogether (Boud & Falchikov, 2007; Ajjawi & Boud, 2016; Hattie & Gan, 2011; Evans, 2013; Winstone et al., 2017; Carless & Winstone, 2020).

5.1.3 Feedback perceptions and feedback practices

Recent studies suggest that the concept of feedback perceptions might be the missing link between the feedback provided to a student and a student acting on provided feedback (Van der Kleij & Adie, 2020; Van der Kleij et al., 2013; Pat-El et al., 2014). Earlier, the process of receiving and acting on feedback was assumed to be linear, suggesting that when provided with feedback, students automatically recognize feedback and act upon it (Winstone et al., 2017). However, Van der Kleij et al. (2013) and Winstone et al. (2017) established that the relationships between provided feedback and applying it are not linear. Scholars argue that there are various factors involved in the ways how instructional feedback is perceived by a feedback receiver. To describe these factors, the concept of 'feedback perceptions' was introduced by Van der Kleij et al. (2013). According to Van der Kleij et al. (2013), feedback perceptions include, for example, students' personal beliefs about feedback, students previous experience with feedback, students' attitudes towards feedback provider, students' personal mental and physical state and conditions of a learning environment. All these aspects shape the view of how feedback is perceived by a feedback receiver – students - which means that feedback perceptions influence whether or not students apply feedback to improve. Since the concept of feedback perceptions emerged, research has largely focused on students' feedback perceptions, while feedback perceptions of educators have not received much attention. In order to study students' feedback perceptions King et al. (2009) developed an Instructional Feedback orientation Scale with four categories to measure students' feedback perceptions. These categories are: a) retention sub-scale to measure how much of a provided feedback students recall; b)

confidentiality sub-scale to measure how comfortable students are being provided with feedback privately and publicly; c) sensitivity sub-scale to measure students' emotional response to one or another type of feedback provided to them; and d) feedback utility, sub-scale measuring how useful provided feedback is according to students. However, no similar progress has been made in attempting to investigate instructors' feedback perceptions. Currently, feedback perceptions amongst the instructors are studied only in comparative analysis with the students' feedback perceptions, exploring similarities and differences in perceptions from students and instructors (Dawson et al., 2018; Brown & Wang, 2013; Wiese & Nortvedt, 2023; Schildkamp et al., 2020).

Moreover, the existing feedback studies tend to be descriptive and focus largely on what instructors do in terms of feedback, rather on than explore the instructors' perceptions about feedback and how these perceptions translate into feedback practices. Understanding how instructors and teaching assistants perceive feedback is important, because feedback perceptions influence what type of feedback is provided and how exactly the instructional feedback is delivered to students (De Hei et al., 2014; Chan & Luo, 2021).

Current research on feedback lacks studies on how university instructors and teaching assistants perceive feedback, and how those feedback perceptions translate to the feedback practices predominant amongst the instructors at the Computer Science program. To address this research gap, the main research questions of this study are following:

RQ1: What feedback perceptions are reported by the instructors and teaching assistants within Computer Science learning environment?
RQ2: How are instructors' feedback perceptions reflected in the design and implementation of feedback practices that aim to facilitate learning in large classes in Computer Science?

With these research questions we aim to explore feedback perceptions and experiences with feedback amongst the instructors and teaching assistants of Computer Science

program in order to understand how feedback is conceptualized. Specifically, we focus on how instructors and teaching assistants perceive feedback, what they think students need and on their intentions behind the type and the way of feedback that is provided to students. We conclude by offering possible directions for further research that will help to better understand the complexity of feedback and feedback perception concepts. We also include practical implications for educators to increase feedback literacy in higher education.

5.2. Method:

5.2.1. Participants and Data collection

We administered individual semi-structured interviews with five lecturers and three teaching assistants of the Computer Science program. The data was collected from instructors and teaching assistants involved in teaching first-year undergraduate students of the Computer Science program during the first semester. We used a convenience sampling strategy (Cohen et al., 2007). We purposely chose instructors and teaching assistants involved in first semester as the transition period is crucial in terms of preliminary indication of students' success later on, as students, including high-potential students, who fail to manage transition successfully drop out in this period as mentioned by De Laet et al. (2016), by Bangser (2008) and by De Clercq et al. (2021). Scholars argue that the possibility of losing high-potential students in the transition period puts extra pressure on instructors and teaching assistants because students require support in navigating challenging new environment. All participants were recruited in close collaboration with Computer Science program leadership. Open invitations were sent to potential participants and all the participants who responded were informed about the goal of this study and signed an informed consent form (Cohen et al., 2007). The instructors were males with on average 3 years of teaching experience. Two teaching assistants were females and one was male, and teaching assistants had on average 3 years of experience supervising and supporting undergraduate students of the Computer Science program. All participants had a background in Computer Science. All participants varied in terms of age and cultural backgrounds.

Within the teaching community of Computer Science at Delft University of Technology, instructors hold an engineering degree or a degree in Computer Science, followed by a University Teaching Qualification course.

The main goal of the interviews was to explore what feedback perceptions are reported by respondents and how the reported feedback perceptions are reflected in designing feedback practices to facilitate learning in large classes in Computer Science program.
This study was evaluated and approved by the Delft University of Technology Human Research Ethics Committee. The researchers of this study had no formal relationships nor responsibilities under the Computer Science program.

5.2.2. Instrument

Since the concept of feedback perceptions is rather new, most studies exploring feedback perceptions are aimed to investigating the concept itself (Dawson et al., 2019; Winstone et al., 2017). As part of these efforts standardized instruments were developed to collect data on the frequency and amount of feedback provided in classrooms, while the quality of these feedback practices and the root causes explaining the quality behind feedback practices are often overlooked (Van Beek et al., 2019). To gain in-depth understanding in feedback perceptions and feedback practices amongst instructors and teaching assistants, we chose semi-structured individual interviews. We chose a semi-structured interviews format to ensure the uniformity of main questions for every participant, and give every interviewee freedom and flexibility to think 'aloud' providing us with elaborated comments and remarks (Charters, 2003; Fonteyn et al., 1993).

The interviews questions were divided into two main topics:

a) Instructors' and teaching assistants' feedback perceptions: what do instructors and teaching assistants think feedback is; what type of feedback do instructors and TAs provide to students; what do the instructors and TA's want students to do with

feedback provided; what do instructors and TA's think students want from feedback.

b) Feedback practices that facilitate learning in large classes in the Computer Science program: how do instructors and teaching assistants provide feedback practices; when providing feedback what do instructors and teaching assistants focus on; how do instructors and TAs ensure that those feedback practices facilitate learning.

5.2.3. Philosophical framework

The aim of this study was to explore how instructors and teaching assistants perceive feedback and what do instructors and teaching assistants do to facilitate learning in their classes by means of feedback practices. With this aim in mind, we chose the phenomenological approach for this study. The phenomenological approach allowed us to describe participants lived experiences right in the moment of collecting the data (Creswell, 2007). Phenomenology focuses on what all participants have in common while maintaining individual experiences. In this study, the phenomenon we focus on is providing feedback to students and all experiences related to feedback.

5.2.4. Analysis

The interviews were audio-recorded, transcribed verbatim and anonymized. The interviews ranged between 20 minutes to 55 minutes. All interviews were analysed as a single data-set. To maintain reliability of the analysis, each round of coding was carefully evaluated by the research team.

We used Atlas.TI software to analyse the transcripts. After transcribing the recorded conversations, we used an inductive approach of the Thematic Analysis exploring the summarized commonalities of phenomenon (Braun & Clarke, 2006; Miles et al., 2013). We analysed the transcripts selecting, identifying and coding each of the transcripts one by one assigning the combination of pre-determined codes from the literature review and the emerging codes from the data itself to the segments of the transcript text that according to

the first author referred to feedback: instructors' and teaching assistants' beliefs about feedback, experience with feedback, use of particular feedback practices. By choosing an inductive approach we acknowledge that as feedback scholars we bring a specific theory to the topic on a basis on which we construct main themes (Varpio et al. 2017).

As mentioned by Guest et al. (2012) and Chang and Wang (2021) thematic analysis focuses on subjects' perceptions, experiences and feelings subjectively, the thematic analysis is compatible with the phenomenology: a phenomenology highlights the perceptions, feelings and experiences of the participants, while thematic analysis provides a theoretically informed interpretation of meaning of the phenomenon observed (Braun & Clarke, 2006). The thematic analysis in the current study was conducted via the iterative process of coding, examining and re-examining the textual data to generate meaning and refine the themes. Braun and Clarke (2006) warned that one of the disadvantages of pre-defined themes in Thematic analysis is that while focusing on patterns, single-event phenomena tend to be overlooked. Therefore, certain text segments that were not necessarily related to our research questions, but contributed to understanding the phenomenon, were also coded in vivo (Braun & Clarke, 2006).

Since the first research question explores all possible experiences, thoughts and elaborations on what instructors consider feedback and how instructors and teaching assistants perceive feedback, we first selected all text segments where feedback was mentioned, as well as all quotes and interview segments where instructors and teaching assistants were involved in providing feedback to students. The first author then went back and forth to the chunks of interview text and coded simultaneously, assigning the main themes to the pieces of text.

Next, the first author extracted the chunks of the interview texts and grouped them based on similar themes.

In the **Results** section, quotes are provided to explain the themes emerged from the analysis. Quotes are written in Italics and are marked with quotation marks. Quotes are also assigned with the corresponding interview participant: instructor or teaching assistant. In the Results section we refer to the five instructors as I1 to I5 where 'I' stands for 'Instructor'. The three teaching assistants are referred to as TA1, TA2 or TA3, where 'TA' stands for 'teaching assistant'.

5.3. Results

In this section, we present the findings that emerged from individual semi-structured interviews with instructors and teaching assistants.

The first research question sought to explore how instructors and teaching assistants perceive feedback. Instructors and teaching assistants were asked what they think feedback is. In order to draw a clearer picture, we also explored multiple aspects of what instructors and teaching assistants think of feedback, such as what type of feedback do instructors and teaching assistants provide to students, what do they want students to do with the feedback and what do students want from feedback according to instructors and teaching assistants. We present the results clustering under the main themes that we derived from data.

5.3.1. Feedback perceptions

RQ1. What feedback perceptions are reported by the instructors and teaching assistants within Computer Science learning environment?

Based on the answers we received from the instructors and teaching assistants, five main themes emerged from the data. All five themes were related to what is believed to be the main purpose of feedback as perceived by the instructors and teaching assistants. Following themes together with the quotes from the respondents are described below:

a) Feedback helps to improve.

Instructors and teaching assistants suggested that feedback serves as an indication of how well the learning material is acquired by student: “Feedback is given for the purpose of improving: it shows the missing information, helps to close the gap.” (I1)

During the interviews instructors and Tas focused on written feedback that is given for exams. Formative feedback was mentioned but not focused on. Any additional comments that students receive together with the grade are aimed to justify the grade, and not on providing suggestions or explanations of made mistakes or directions to improve learning. Instructors elaborated that students often ask for more detailed feedback as in what exactly was wrong. When providing feedback to students, instructors and teaching assistants focus on grade justification and not on clarifying learning flaws and ways to manage them: “I typically get a lot of emails afterwards, questioning the grade. Like, why is this only a nine? And I think, like a nine is already a high grade, but they are not satisfied with that. And then I have to provide very clear reasoning, for why it is not a 10. And even then, they [students] come back with emails where they state their arguments and why it [grade] should be higher.” (I2)

All participants suggested that grades create sufficient clarity of quality of the learning. An example of this assumption is demonstrated in the following quote: “They [students] should be able to see from their grades that they are missing something. I mean, if I get a 6 instead of 8 or 10, it is clear to me that I need to study more.” (TA2)
Teaching assistant suggested that by getting low(er) grades, students are able to see what they do wrong or not good enough and put more effort to improve learning.

b) Feedback directs students into next steps on learning.
Both instructors and teaching assistants shared the ideas that feedback helps students to understand what next steps in learning they need to take. Following quote from the instructor assumes that students can see from feedback they receive what the next steps

are: “Feedback shows next steps in moving forward with learning. It has clear criteria of what was done well and what not.” (I5)

In this feedback perceptions, feedback is serving as a tool to improve knowledge by locating the knowledge gap and closing it effectively. The main issue with this statement is that students get grades rather than written feedback or comments.

c) Feedback as a motivational tool.

During the interviews, Tas shared a common perception for instructional feedback to act as a motivational tool for students – a reward and an indication of academic achievement. Instructors shared the idea of feedback serving as motivational tool; however, it was mostly the teaching assistants who perceived instructional feedback to be motivational. The following quote shows an example of this assumption: “Feedback helps students to realize they can do better. It motivates them to get that reward they want.” (TA3).

The main reward explained by the respondents was an external reward in the form of a high grade or praise from the supervising teaching assistant. None of the respondents mentioned any examples of an internal reward, such as, for example, the satisfaction of task done or achieving one’s personal learning goals.

d) Feedback stimulates low achieving and reluctant students.

In lieu of the results under c, feedback was perceived as a tool to stimulate underachieving students. The following quote unveils several assumptions: “Feedback is used to shake the students awake a little bit so that they start taking actions for their learning. It is like a reality check for students who do not take it [studying] seriously.” (I4)

Here, the instructor seems to assume that underachievement is mostly the result of low effort in learning, but also that students who get lower grades compared to the rest of the group do not take studying seriously.

e) Feedback provides an evaluation on teaching methods and approaches.

This feedback perception emerged solely from interviews with instructors. According to instructors, feedback provides an indication on how well teaching is designed by the instructor. The following quote demonstrates what instructors mean with feedback serving as an evaluation of one's teaching: "Feedback helps to evaluate the content of my lectures: I see where students make the most mistakes and then I try to change it so students can understand it better." (I3)

This feedback perception indicated instructors' desire and intentions to help students learn. By focusing on areas where students make the most mistakes, instructors assume that these areas were not clear enough for students and need to be revisited or redesigned. By improving their own teaching, instructors hope to notice less mistakes in certain areas that had most students struggling with. In instructors' eyes less commonly-made mistakes indicate that the chosen teaching style, method and tools are appropriate and successful.

We asked instructors and teaching assistants to elaborate on what do they want students to do with the instructional feedback that is provided. Majority of answers included high-cognitive and meta-cognitive techniques that students are expected to demonstrate once they receive instructional feedback. According to the feedback providers, when received instructional feedback, students should demonstrate following learning strategies:

a. Evaluate one's learning and personal learning goals. In other words, students need to reconsider if the way they are learning at the moment of receiving feedback is effective in order to achieve their personal learning goals. If not, the learning needs to be changed or adjusted. "When I provide feedback, I want students to evaluate on their learning objectives and check what was done right, what was done wrong." (I1)
b. Find what knowledge is missing and close the gap by learning more about it on conceptual level. "When I give students feedback, I want them to focus on mistakes they made to understand the reasoning behind those mistakes." (I2)
c. Decide on appropriate approach to close the knowledge gap, and execute it. "Feedback is like 'hints' for students; I want them to take the 'hints' and take the following steps in improving their learning." (TA2)

d. Demonstrate improved knowledge by getting the grades that are higher than the minimum requirements for satisfactory achievements. “When I give students feedback, I want them [students] to use it to achieve better performance, better grades.” (I3)

It is clear from instructors’ and teaching assistants’ reports that students are expected to show a high level of cognitive and meta-cognitive skills in perceiving feedback, evaluating and acting on instructional feedback with the highest efficiency in regards to their learning goals and learning strategies.

However, when asked to elaborate on what do students want from instructional feedback according to the opinion of instructors and teaching assistants, the respondents report widely different perspectives.

According to the teaching assistants, students are lazy and reluctant in learning: “If you allow students to be lazy, then they, they kind of will, because they see an easy way. And it's kind of really - I mean, I've been a student myself - choosing the road of the least resistance.” (TA2)

Teaching assistants claim that students do not want to engage with feedback because they just want a high(er) grade, an easy and quick answer and to ‘pass’ the exam. Feedback preferred by students, as suggested by teaching assistants, serves two main purposes: a) feedback is a reward, an acknowledgement of students’ effort in the form of a high(er) grade as the following quote demonstrates: “Feedback is like an acknowledgement: this is what you did wrong, this is what you did well, but kind of acknowledging - Hey, you did this, you know, this is progress. It's good. You learnt something new or whatever.” (TA3); and b) feedback serves as a confirmation that student has found a ‘working’ way to learn, as mentioned in the following quote: “It [feedback] is like a confirmation from you that they're all good on the road.” (TA1)

This observation indicates that according to teaching assistants, students use feedback to reflect whether or not their chosen way to learn is 'working' delivering the results – good grades. Teaching assistants are students themselves and they reflect their beliefs about learning by describing first-year students' perceptions on feedback utility. When stating that exploring appropriate way to learn depends on what instructional feedback is received, teaching assistants imply that students do not make informed decisions about how to approach learning effectively, but rather use a method of trials and errors to see what 'works'.

Opposite to teaching assistants' perspective, instructors assume that students come to university knowing how to learn effectively. None of the participants of the interviews mentioned any involvement into guiding students through learning within the new learning environment. On the contrary, students were expected to be independent learners with high cognitive and meta-cognitive skills: "They [students] should realize the weight of the responsibility and accountability of learning at the university level. They [students] should be able to figure out how to improve their learning." (I3)

5.3.2. Summary: Instructors' and teaching assistants' feedback perceptions

Both instructors and teaching assistants defined feedback as a tool to help, motivate and direct students in their learning. These feedback perceptions, however, according to instructors and teaching assistants belong to the only feedback that students receive – grades. Both instructors and teaching assistants have certain feedback perception that grades that students receive do not only provide enough clarity on knowledge gaps, but also contain information on how to close the gap and improve learning. In practice it implies that students are able to see the differences between different grades as in 6.5 or 8.0 on the 10-point scale.

Feedback is seen as a tool of motivation to receive a reward – better grades. In the opinions of the instructors and teaching assistants, low grades indicate low effort that students put

into learning. Teaching assistants elaborated that low efforts are common amongst students since students are lazy and choose the path of the least resistance in learning. Instructors, on the contrary, perceive students as being capable of effective independent learning when entering the university learning environment.

Despite seeing students as capable of independency in learning process, none of the respondents suggested that students are able to generate feedback internally. According to the respondents, feedback is an external component of learning and is always provided by an external feedback provider – instructors themselves or teaching assistants.

5.3.3 Instructors' and teaching assistants' feedback practices

RQ2. How are instructors' feedback perceptions reflected in the design and implementation of feedback practices that aim to facilitate learning in large classes in Computer Science?

In the interviews, both instructors and teaching assistants reported using grades as the only feedback that is provided to students. Interview participants claimed that despite the intentions of teaching staff to make feedback valuable and relevant to students, certain feedback practices seem impossible to operate in large classes: "To give them that [feedback that students want], I would need to hire an army of TA's. But I can't do that, because we can't afford that. There is a limit [on finances]." (I5)

This statement implies that instructors and teaching assistants think students want personalized feedback. This quote also indicates lack of knowledge and skills that instructors and teaching assistants demonstrate in terms of implementing certain feedback practices to their learning environment.

According to instructors and teaching assistants, providing students with certain feedback practices requires heavy overtime and substantial financial investment of the department to hire more teaching assistants to accommodate students' expectations from feedback.

Some instructors shared personal experience attempting to change feedback practices and to design self-assessment techniques for students. One of the experiences is described by following quote: “I did self-assessment for one of my assignments and then I also added peer-feedback to that. Because I also wanted them [students] to get feedback from peers. I knew they would just grade themselves higher than peers. Then it [the task] was graded by TA’s. And I had a feeling that students spent way more time on it that I anticipated. At the end, that assignment did not go into final grade, so I had a feeling that they [students] spent extra time on something that had no value on their final exam” (I1). This quote implies a lot of different assumptions from the instructor. The attempt to change the existing feedback practice and design a new feedback practice shows instructor’s willingness to support students in learning. However, it also shows that instructor did not succeed in designing appropriate feedback practice, since later in the process also peer-assessment was added, and at the end the teaching assistants were involved in grading the same task. In instructor’s opinion the newly introduced feedback practice was unsuccessful because it resulted in students working more hours than usually to perform a task that had no influence on final grade. Following up on the quote, it seemed to us that this practice was ill conceived which implies that instructor lacked skills, knowledge, competence and experience in designing feedback practices that facilitate learning in his particular learning environment. Both instructors and teaching assistants mention limited time and finances to explain the lack of various feedback practices in their classrooms. These explanations highlight the lack of experience in designing appropriate feedback practices tailored for the learning environment but also indicate the limitations of the learning environment that instructors and teaching assistants face when are willing to change the current feedback situation in their classrooms.

Another instructor shared experience introducing flipped-classroom teaching method and discussion-based lectures to programming course. According to instructors, these approaches led to increased participation and increased engagement amongst students: students were asking more advanced questions compared to questions asked during

'traditional' lectures where instructors simply convey information to students. However, instructors claimed that they lacked time and expertise designing such approaches that are congruent with the purpose and the content of the lecture, as well as students' learning goals.

5.3.3. Summary: Instructors' and teaching assistants' feedback practices

The second part of the interviews involved instructors and teaching assistants discussing their perception of feedback and how those perceptions translate into the feedback practices that are predominant in the classrooms. Reports show that the underlying issue with designing appropriate feedback practices that facilitate learning lies within a lack of resources, experience with educational innovation yet also with a self-proclaimed lack of expertise adjusting educational innovating to one's classroom's setting amongst instructors and teaching assistants. Despite the eagerness and attempts of instructors to change feedback practices, designing and implementing feedback practices that are tailored to the conditions of the learning environment and facilitate learning is still a challenge. Lack of expertise in pedagogy and feedback, as well as certain perceptions towards feedback, such as for example seeing only tangible feedback – grades – as useful, influence the way how and what type of feedback is provided by both instructors and teaching assistants in their classrooms.

5.4. Discussion

This aim of this study was two-fold: We explored feedback perceptions that the instructors and teaching assistants of Computer Science program have, and we explored in what way are those feedback perceptions translate into feedback practices that instructors and teaching assistants use to provide feedback to students to facilitate learning. Our findings show that feedback perceptions that are reported by instructors and teaching assistants translate to certain feedback practices that are predominant at the Computer Science program. We also discovered that the negative experience with certain feedback practices contributed to strengthening of certain feedback perceptions: failed attempts to change the

feedback practices within one's classroom setting resulted to strengthening educators' beliefs that those feedback practices are less effective than the feedback practices educators commonly use. These findings are consistent with the concept of feedback perceptions by van der Kleij et al. (2015) who states that negative experience with feedback and feedback practices impact the way how feedback is perceived. The existing research in feedback perceptions amongst the educators is limited, focused on quantitative data and comparative analysis of feedback perceptions amongst educators and students (Lee et al., 2016; Zhan, 2016; Dawson et al., 2019; Chan & Luo, 2022; Robinson et al., 2013; Roselli & Brophy, 2006; van der Kleij, 2019). To our knowledge, there have been no attempts in research community to explore educators' feedback perceptions separately from perceptions of the students. Nor there have been no attempts to explore educators' feedback perceptions in conjunction to feedback practices that are commonly used by the educators. Therefore, our goal was to explore the qualitative data of the concept of feedback perceptions due to the lack of studies with similar goal. Using qualitative data allowed us to investigate the underlying issues and challenges behind the feedback practices that are used by instructors and teaching assistants in Computer Science program. It also allowed us to understand issues and challenges that instructors and teaching assistants face when implementing and scaling-up feedback practices that facilitate learning and what feedback perceptions influence those challenges. Semi-structured individual interviews with instructors and teaching assistants involved in teaching first-semester undergraduates in Computer Science allowed us to collect abundant data on experiences, feelings, thoughts and perceptions regarding the concept of feedback and feedback practices as experienced by the instructors and teaching assistants.

Van der Kleij et al. (2015) included many various internal and external aspects in what shapes one's feedback perceptions. Indeed, the feedback perceptions that demonstrated our participants involved wide variety of assumptions. Both instructors and teaching assistants perceive feedback as valuable tool to improve one's learning. According to the reported data, feedback: a) provides clarity on knowledge gap; b) suggests further steps to

close the knowledge gap; c) motivates high performing students; d) stimulates low performing students; and e) acts as an evaluative tool for instructors to reflect on their teaching. These feedback perceptions demonstrate positive attitudes towards feedback and willingness of the instructors and teaching assistants to help students learn. By means of feedback instructors analyse students' work and try to see patterns in students' mistakes or knowledge gap. The idea behind this analysis is to influence students' learning by changing between different styles and methods of teaching. This feedback perception indicates that instructors are indeed aware of feedback being influential for students' learning (Hattie & Timpereley, 2007), but instructors' and teaching assistants' lack of expertise in the area of feedback does not allow them to successfully operate various feedback practices to facilitate learning. Although being equipped with different feedback tools, educators struggle with use them appropriately (Boud & Molloy, 2012). A strong example of this observation is given by the instructors themselves when they shared failed attempt to change the way feedback was provided to students by introducing self-assessment. The entire change resulted in both instructors and students being dissatisfied with time spent on feedback practice and the results of it. Another example involved flipped-classroom for programming class which resulted in higher student engagement but lower progress amongst the students since the flipper-classroom method was not appropriate for the conditions and learning goals of a programming class. Failed attempts to introduce other types of feedback result in instructors' and teaching assistants negative feedback perceptions (van der Kleij et al., 2013). Such negative feedback perceptions are reported as: a) feedback that students want requires time and effort; b) feedback that students want is time-consuming because it is c) personalized; d) feedback students want requires additional financial investment; e) feedback students want is tangible because it acts as a reward. Investing time and finances into hiring more teaching assistants to provide students with personalized feedback is not an option for instructors. Especially, when teaching such a large group of more than a hundred students. Teaching and feedback in such large group is a well-known issue amongst scholars and educators (Cohen-Vogel et al., 2015; Fishman et al., 2014; Boud & Molloy, 2012; Broadbent et al., 2017; Ake-Little et al., 2020; Diette & Raghav, 2015). However, such

conditions of a learning environment as large class have not yet been linked to instructors' feedback perceptions.

These negative feedback perceptions contribute to certain attitudes towards changing the feedback practices that present at Computer Science program. According to Pajares (1992), instructors' beliefs and attitudes about feedback influence instructors' feedback perceptions, and as a result, those feedback perceptions determine what feedback is provided to students. In other words, feedback perceptions that are present amongst our interview participants translate into feedback practices that are predominant in Computer Science program. The example of this statement is that the main feedback students get is grades. Instructors and teaching assistants do not know how to appropriately use feedback to facilitate learning, and it becomes clear that grading is used as the only type of feedback that is provided to students. Instructors and teaching assistants believe that feedback with its affirmative function is interesting to students only if it comes as a measurable reward – grade. These beliefs were also noticed by Carless (2006) amongst Hong Kong tutors' feedback perceptions. According to the author, tutors from Hong Kong university believed that students are not interested in anything but grades. Similar results emerged in many other studies (Duncan, 2007; Winstone, Nash, Rowntree and Parker, 2017; Mensink and King, 2020; Rand, 2017). In our data, teaching assistants share similar opinion about students being lazy, reluctant learners who are only interested in higher grades as a reward for their efforts. This perspective is reflected back to a certain feedback perception that motivates students to get a reward – higher grade and stimulates low achieving students. Since teaching assistants believe that students are lazy and reluctant, low grades for them indicate low effort students put into studying and not taking learning seriously. Contrary to the opinions of teaching assistants, instructors perceive students as independent learners. Instructors believe that when entering university, students are expected to be able to learn independently, organizing one's learning process successfully. Hence the feedback perceptions that grades provide sufficient clarity on knowledge gap and directions for

improvement. Both instructors and teaching assistants expect students to take feedback that is given to them and use it to improve learning.

This observation is consistent with a misconception of feedback process noticed by Winstone et al. (2017): a common assumption that when feedback is provided, it is automatically evaluated and acted upon. This misconception leaves no room for students misinterpreting feedback or even ignoring it consciously or unconsciously.

All our respondents struggled with using feedback to facilitate learning in their classrooms. The main reason of these struggles as stated by instructors and teaching assistants themselves is lack of expertise. Although insufficient training and lack of expertise amongst university instructors was suggested before in several studies (Boud, 2010; Boud & Brew, 2016), it was not yet linked to the concept of feedback perceptions before. From the first glance, instructors and teaching have certain feedback perceptions that influence the way how feedback is provided to students. However, from the closer look our results show that there is a dynamic interplay between feedback practices, feedback perceptions and learning environment. Our findings show that feedback perceptions influence feedback practices that are predominant within the Computer Science program. At the same time, lack of pedagogical knowledge and skills result in failed attempts of changing the existing feedback tools which also contribute to certain feedback perceptions amongst the instructors and teaching assistants. Large class and Computer Science program play contextual role in this interplay. However, since these conditions of the learning environment are challenging for instructors and teaching assistants to operate with, the context of this study also contributes to certain feedback perceptions amongst the instructors and teaching assistants which results in specific feedback practices used. From the reported shared experiences of instructors who attempted to raise students' engagement by means of applying various teaching styles and changing the 'traditional' lecturing approaches, we see that the main reason behind the unsuccessful attempts was self-proclaimed lack of skills in facilitating learning and using appropriate feedback tools. These findings are especially crucial in the areas where instructors do not have sufficient teaching qualifications apart from being an

expert in their specialization (Boud & Brew, 2016). Boud and Brew (2016) suggest that there is a common assumption that the short teacher trainings required from the instructors and teaching assistants is considered sufficient and that the knowledge can be acquired through the provision of the coursework, however this study indicates a clear gap in knowledge that has been overlooked before.

5.5. Conclusion, limitations and future work

This study provides the ground for further investigation in the field of feedback perceptions amongst instructors and teaching staff of Computer Science education by showing that it is feasible and worthwhile to explore feedback perceptions and their influence on feedback practices in large classes within Computer Science education.

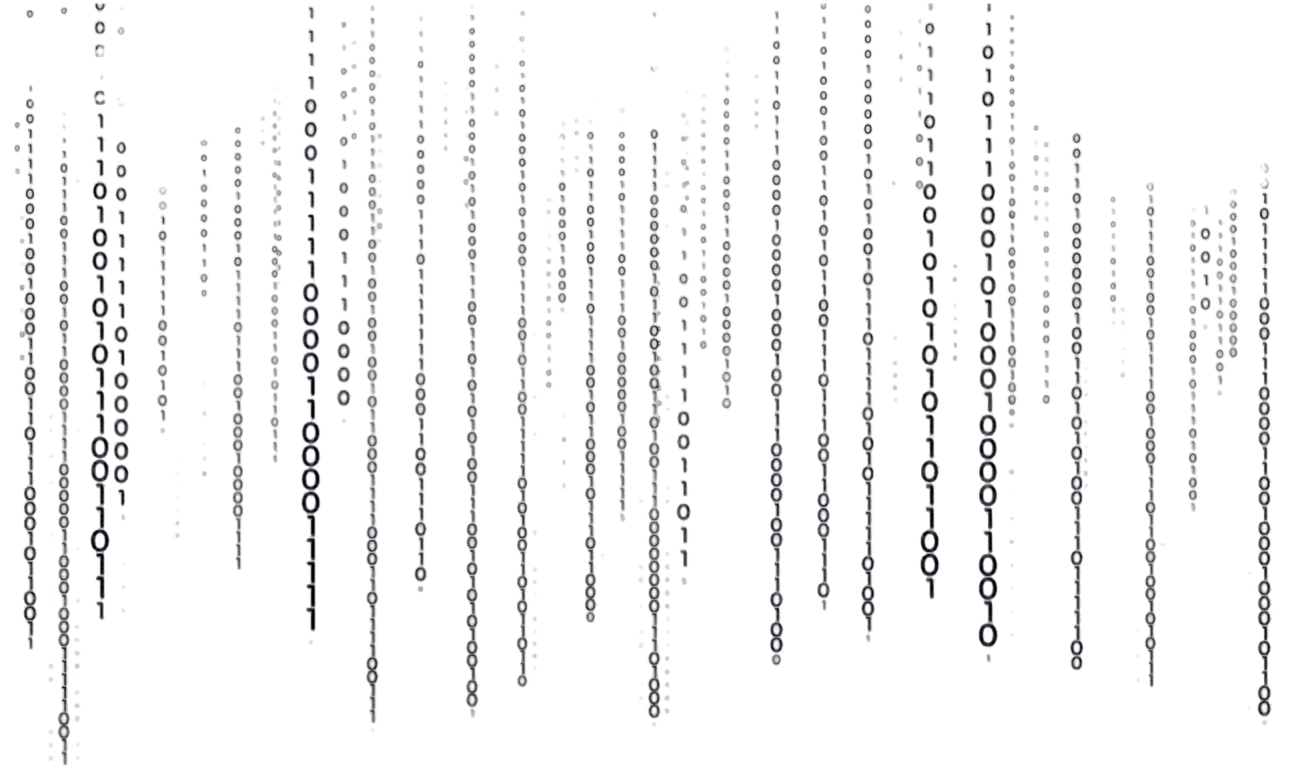
Providing students with high-quality feedback is fundamental requirement from instructors and teaching assistants. However, to be able to do so, educators are not only required to demonstrate knowledge and skills in the main domain – Computer Science, instructors and teaching assistants are also required to demonstrate their expertise in pedagogy – appropriate feedback in large classes to facilitate learning. Without appropriate knowledge, this process becomes challenging, time-consuming activity that leaves both educators and students confused. As a result, instructors and teaching assistants do not only lose enthusiasm and hope in students' learning process, they experience pressure and a heavy load of unrealistic expectations from the policy makers, scholars and faculty management (Borrego, 2007; Lane et al., 2014; Huusko & Ursin, 2010). Most instructors and teaching assistants want to support students in learning, however, this study showed that the instructors and teaching assistants do not know how to do that in practice, within the limiting constrains of the given learning environment and their own feedback perceptions.

As most exploratory studies, this study has its limitations. The participants that took part in the interviews consisted of a very limited number of instructors and teaching assistants from only one university. Moreover, the interviews respondents were not randomly selected and

it is not possible to exclude the participation bias. However, we consider this sample to be a representative group for it was the entire group of instructors involved in teaching undergraduate students of Computer Science in the first semester.

For future research, a phase of quantitative data collection should be carried out to build on the results of this qualitative study. As suggested by Creswell (2003), collecting the quantitative data may assist in the interpretation of the qualitative results for the purpose of generalization of these qualitative results to similar samples.

Practical suggestions for educators would include additional trainings and dialogs with feedback experts in the area of feedback that focuses on specific needs of each individual educator and their classroom conditions to obtain essential pedagogical knowledge and skills to provide feedback that facilitate learning.



Chapter 6. Conclusion and discussion

6.1 Introduction

This dissertation aimed to contribute to theoretical and practical knowledge on feedback perceptions that enhance students' learning. The research question that was leading this thesis was: "What role do students' and instructors' feedback perceptions play in students' learning in large groups within Computer Science education?". To answer this question, this thesis investigated what feedback perceptions students have and how those feedback perceptions impact students' learning and motivation. This thesis also investigated what feedback perceptions instructors have, and how instructors' feedback perceptions influence the feedback practices that are commonly employed by instructors at Computer Science program.

It is important to understand what feedback perceptions students have because those feedback perceptions act as a precursor to students' 'right mindset' and willingness to accept instructional feedback, make sense of it and utilize it to improve learning (Handley et al., 2011). It is also crucial to understand what learning strategies students engage in when an action plan to utilize instructional feedback is drawn, and how feedback perceptions impact the learning strategies that are commonly used by students, taking into account the recent findings that students tend to engage in ineffective learning strategies (Dunlosky and Rawson, 2015). The impact of instructors on students' effective uptake of instructional feedback is limited, since students have individual agency deciding whether or not to act upon instructional feedback. However, it is essential to understand what feedback perceptions do instructors have. Instructors' beliefs about feedback, for example, influence the type of feedback practices that are commonly used by instructors (De Hei et al., 2014; Chan & Luo, 2021). As a result, certain feedback practices are being continuously used, even when such practices have limited or even negative impact on students' learning.

In this dissertation we also aimed to provide a comprehensive overview of all the aspects of learning environment that might play role in how students and instructors experience learning and teaching Computer Science, and therefore, influence what feedback

perceptions are present in our population. Such aspects included: large class, the context of Programming in Computer Science education, the period of transition from secondary to higher education.

Through conducting four in-depth studies: two qualitative, one quantitative and one mixed-method; we explored different aspects of feedback perceptions amongst students and instructors at Computer Science education. Students' feedback perceptions in large learning environment were investigated (Chapter 2). An association between students' feedback perceptions and students' motivation and learning strategies were investigated as well (Chapter 3). Students' feedback perceptions, and students' motivation and commonly used learning strategies to utilize instructional feedback were studied in details (Chapter 4). Instructors' feedback perceptions and the set of commonly used feedback practices that reflect those feedback perceptions were explored thoughtfully (Chapter 5). The following section includes the summaries with the findings and conclusions for these four studies. Followed by a general discussion, limitations of current study and suggestions for future research. The final section addresses the practical implications of current findings for instructors, scholars and policy makers.

6.2 Findings and conclusions for each study

The study presented in Chapter 2 was guided by the research question: "How do first-year bachelor students of Computer Science perceive feedback?". The study was done with students at Delft University of Technology in the Netherlands. The aim of the study was to gain insights into how students perceive instructional feedback – whether students recognize and accept instructional feedback, and what characteristics of the learning environment are mentioned in conjunction with students' reported feedback perceptions. To elicit the students' feedback perceptions and experiences with instructional feedback within the new learning environment – large class during transition period – we conducted semi-structured group interviews. Questions were based on the elements of feedback perceptions concluded by van der Kleij et al. (2015) to have influence on students' attitudes

towards instructional feedback. Such questions included, but not limited to, following elements for group discussion: students' beliefs about feedback, students' experience with instructional feedback in secondary education and higher education, students' perception of instructional feedback given at current program of Computer Science, students' experiences learning in large class, studying complex material, and reported difficulties students face within the new learning environment during the first semester. The interviews started with how students perceive the instructional feedback and explored some of the aspects that may influence those perceptions. The interviews were conducted with the same students – 17 first-year undergraduates – three times during the first semester: in the beginning, in the middle and in the end of the first semester to capture and reflect on fluctuations in students' attitudes towards instructional feedback and students' experience of the new learning environment. The data analysis revealed that students perceived instructional feedback as useful and important for one's learning, however, students reported that they rarely used instructional feedback provided to them. Students reported following reasons to not engage with instructional feedback: (a) grades being the only type of feedback students receive; (b) lack of skills and knowledge to apply feedback practically; and (c) lack of motivation to engage with instructional feedback. Students reported that since grade is one of the most commonly used instructional feedback that they received, after getting a grade there was no strategy nor willingness to engage with instructional feedback. The data analysis also revealed several aspects of the learning environment that were reported by students in conjunction to feedback perceptions they have. Such aspects included: (a) large class and large variety of prior knowledge in the group, (b) several aspects of the context: complexity of knowledge domain, high pace of lectures, study load; and (c) external aspects such as feeling homesick, transitioning to new learning environment, lack of support and guidance from teaching staff. Students reported that all those elements influenced their experience of learning in the new environment, which in turn had impact on students' feedback perceptions, students' motivation and students' learning strategies. These findings are important because contrary to popular misconception that when feedback is perceived as useful, it is automatically applied to improve learning (Torrance,

2012; Winstone et al., 2017), our findings show that even when students perceive instructional feedback as useful, students still have a large range of reasons to not engage with instructional feedback. Students' responses about inability to proceed with learning are also consistent with the statements of Bjork et al. (2013) who concluded that students are not well equipped with various learning strategies, nor students are aware of effectiveness of different learning strategies. These findings suggest that effective learning is not natural nor evident to students. The findings also highlight the importance of studying feedback perceptions that act as a precursor to students' motivation to engage with feedback and students' consequent actions in learning.

In the study presented in Chapter 3 we sought to investigate the association between students' individual feedback perceptions and various learning strategies that are employed by students in our population. The research question that guided this study was as following: "What are the associations between feedback perceptions and learning strategies amongst first-year bachelor students of Computer Science?". The aim of this study was to investigate whether or not certain dimensions of instructional feedback perceptions had connections with certain learning strategies that students employ. In other words, whether how students perceive instructional feedback had any relationships with what learning strategies they used. To investigate that, we decided to combine two instruments to collect the data. The Motivated Strategies for Learning Questionnaire (McKeachie et al., 1993) was used to investigate students' motivation and students' learning strategies, while the Instructional Feedback Orientation Scale (King et al., 2009) was used to collect data on students' feedback perceptions. The combined questionnaire was administered through Qualtrics to the entire cohort of students of Computer Science program during the first semester. The results showed significant correlation between two dimensions of Feedback perceptions and six scales of the MSLQ: two scales belonging to Motivation category and four scales from Learning Strategies category. Our findings revealed the significant relationship between how useful students perceive feedback and students' intrinsic motivation and self-efficacy. The same scales of Motivation category – intrinsic motivation and self-efficacy – correlated

highly also with Feedback retention scale, which measures students' ability to recognize, accept and remember instructional feedback. Students' perceived usefulness of instructional feedback had significant connection with learning strategies aimed on activating of the new knowledge and self-regulating of the learning process. Students' ability to recognize and accept instructional feedback also correlated highly with activating and organizing of the new knowledge and self-regulation, but also with learning strategies aimed on organizing time, effort and learning environment. Our findings indicate that students' feedback perceptions – more precisely students' perceived usefulness of instructional feedback and students' ability to recognize and accept instructional feedback – had significant relationships with students' intrinsic motivation and self-efficacy, as well as several learning strategies that are employed by students. Those results indicate that feedback perceptions act as strong predictors to students' motivation and students' choice of certain learning strategies.

Following the exploration of students' feedback perceptions, students' motivation and learning strategies described in Chapter 3, Chapter 4 delves deeper into challenges, issues and difficulties that students experience within the new learning environment in relation to students' feedback perceptions, motivation and students' learning strategies. This study was led by the following research questions: (1) "How do students of large classes in Computer Science program perceive instructional feedback?"; and (2) "What motivation and learning strategies do students of large classes in Computer Science program report for applying the instructional feedback they receive?". To get the full picture, we collected quantitative and qualitative data simultaneously during the first semester. To collect quantitative data regarding students' feedback perceptions and students' motivation and learning strategies, we administered the combined version of the questionnaire used in previous study – the Motivated Strategies for Learning Questionnaire and the Instructional Feedback Orientation Scale. At the same time, we conducted a set of interviews with students to collect qualitative data to get the in-depth insights. We performed the semi-structured group interviews three times during the first semester. Since the data was collected simultaneously, it allowed us to

triangulate the results obtained in both data sets: we were able to compare students' questionnaire responses to students' shared experiences from the interviews. Our findings revealed that students have difficulties applying instructional feedback to improve learning. While instructional feedback is perceived as valuable, it is not always applied and students reported the main difficulty is not knowing how to apply instructional feedback to improve learning. Students do not know how to proceed with learning and struggle to ask help. According to students, lectures are poorly structured, with high load of information and little opportunity to ask for help or ask questions from instructors and fellow students. According to Hornsby-Osman (2014), large classes often reinforce lecture-based teaching which results in lack of meaningful interactions between instructors and students. This often results in increased anonymity and reluctance amongst students, which leads to students' poor engagement in learning. By the third round of interviews, we see similar result – most students do not come to the lectures and study at home. The questionnaire also showed low scores in such learning strategies as Help Seeking and Peer Learning. The lowest scores reported by students amongst the learning strategies were distributed within the scales that aimed on organizing and applying new knowledge. While Dunlosky and Rawson (2015) claim that such learning strategies might be effective in the beginning of the study, students reported no change in their learning styles later in the data collection. This indicates that students are not aware of a wide variety of learning strategies, nor they know how to utilize learning strategies appropriately.

In the study presented in Chapter 5, we switch the focus from students to instructors in order to get the full picture on feedback perceptions and feedback practices that are commonly used by teaching staff. This study aims to investigate how instructors and teaching assistants perceive feedback and how those feedback perceptions translate into commonly used feedback practices for Computer Science program. To guide the study, two main research questions were formulated: (1) "What feedback perceptions are reported by the instructors and teaching assistants within Computer Science learning environment?"; and (2) "How are the instructors' and teaching assistants' feedback perceptions reflected in

the types of feedback practices that are used in large classes in Computer Science program?". Previous research indicates that certain beliefs and attitudes towards feedback act as the precursors to certain feedback practices being favourable and used commonly amongst teachers (De Hei et al., 2014; Chan & Luo, 2021). Other studies claim that instructors' preference in certain types of feedback practices are rooted in the culture and discipline (Fuller et al., 2013; Lattuca et al., 2010, Henderson et al., 2017; Fuller & Skidmore, 2014). Therefore, it is essential to investigate what feedback perceptions instructors and teaching assistants have and how those feedback perceptions are reflected in specific feedback practices that are promoted within Computer Science program. To investigate this, we conducted semi-structured individual interviews with five instructors and three teaching assistants of the Computer Science program. We used a convenience sampling strategy: we specifically focused on lecturers and teaching assistants that are directly involved in teaching first-year undergraduate students during the first semester (Cohen et al., 2007). The in-depth analysis of the interviews revealed that there is an entanglement of the concept of feedback and perceptions of feedback amongst the instructors and teaching assistants. When talking about instructional feedback, instructors and teaching assistants conceptualize instructional feedback positively – feedback was reported to be an important tool that provides clarity on knowledge gap, suggests following steps in closing this gap, motivates students to learn, and helps to evaluate one's teaching. However, our findings also revealed that instructors have negative feedback perceptions regarding the concept of feedback described above. Our interviewees reported following beliefs regarding instructional feedback: (a) feedback that students want requires time and effort; (b) feedback that students want is personalized; (c) feedback that students want required additional financial investments to hire more teaching assistants; and (d) feedback that students want is tangible because students want reward. These feedback perceptions contribute to certain attitudes towards instructional feedback, which resulted in grading being the preferred type. These findings are consistent with the conclusions of Pajares (1992) and Carless (2006), who established that instructors' beliefs influence the attitudes towards using one or another type of feedback. Instructors and teaching assistants explain

their current negative attitudes towards feedback by lack of expertise on how to design, adjust and implement appropriate feedback practices for such large groups. Instructors and teaching assistants also reported previous negative experience using feedback practices that did not help students and instructors themselves to promote learning, which strengthened their negative perceptions about feedback practices. These findings demonstrate the willingness of instructors and teaching assistants to support students in learning, however these results also demonstrate the lack of skills and knowledge in using appropriate feedback practices in large classes that influenced instructors' feedback perceptions. Those negative feedback perceptions in turn reflected in grading being the predominant feedback practice in Computer Science classrooms.

6.3 General discussion

This research aimed to investigate what – feedback perceptions amongst students, instructors and teaching assistants of Computer Science program; and how – the influence of feedback perceptions on both instructors' teaching and students' learning. The following sections provide a discussion of the findings of all the four studies.

6.3.1 Insights on students' feedback perceptions, motivation and learning strategies in Computer Science education in large classes

This research highlights the importance of feedback perceptions as a missing link between instructional feedback and student's learning. Recently increased interest in feedback and feedback perceptions in higher education shows a positive trajectory of research aimed to understand the concept of feedback perceptions and how those feedback perceptions influence student' learning. Previous research in students' feedback perceptions show that the relationships between feedback perceptions and students' learning are not linear. Positive feedback perceptions do not always result in effective learning (van der Kleij & Lipnevich, 2020). Moreover, each students' individual agency in acting towards instructional feedback makes it hard to define any precursors for students' effective learning. The literature review, presented in Chapter 3, for example, explain a large variety of students'

cognitive and behavioural responses to instructional feedback. Indeed, Chapter 2 provides an overview on various aspects that students report as important aspects that influence whether or not instructional feedback will be used. Such aspects, for example, are the type of feedback itself, lack of motivation to engage with instructional feedback, and lack of knowledge about how to apply feedback effectively. Results of the study presented in Chapter 2 show that even when students perceive instructional feedback as useful, it is hard to proceed with effective learning strategy to apply such instructional feedback. Students do not know how to use instructional feedback provided to them and are not aware of cognitive effectiveness of various learning strategies.

Challenges in how to apply instructional feedback are also discussed in Chapter 4. In Chapter 4 our findings show that indeed, students have positive perceptions of instructional feedback, but due to the lack of skills and knowledge on how to apply instructional feedback, students struggle with what learning strategies to engage with. Bjork et al. (2013) warns about students' unpreparedness to engage in various learning strategies. Bjork's claims are similar to Cervin-Ellqvist et al. (2020) statements that students often engage in ineffective learning strategies, because students believe such strategies to be effective. Despite the theoretical and practical evidence, the situation remains unchanged. Our findings give rise to the question whether making explicit suggestions on learning strategies when providing feedback to students could support students towards effective learning.

This research has helped to reveal the relationships between students' feedback perceptions and students' learning strategies and students' motivation. In Chapter 3 we established the link between two feedback dimensions and four learning strategies. Our results showed that students' perceived usefulness of feedback and students' ability to recognize and accept instructional feedback correlated significantly with students' motivation and several learning strategies. Such learning strategies were focused not only on activating and organizing of the new knowledge, but also included metacognitive self-regulation, which shows, if compared to the table of Dunlosky and Rawson (2015), high

effectiveness on student learning. These findings emphasize that instructional feedback should not only be perceived as useful, students need to be able to recognize it and accept it. This condition is neglected by majority of studies on feedback perceptions, suggesting that when feedback is provided to students, students automatically recognize it and are willing to accept it (Handley et al., 2011; Winstone et al., 2017). Opposite to the expectations, students are required to be in the 'right' mindset – motivated to engage with instructional feedback, however, this requirement is often overlooked in current research.
The main difficulty with students' motivation to engage with instructional feedback is that the role of students' motivation in receiving and acting on feedback is still heavily understudied. The study presented in Chapter 3 shows strong positive correlation between feedback perceptions and students' motivation. Such aspects as intrinsic motivation and self-efficacy have strong relationships with feedback perceived as useful and students' ability to recognize instructional feedback. When students are able to recognize instructional feedback and see it as useful, students' intrinsic motivation increases together with students' beliefs about completing the task successfully. High self-efficacy is an important precursor of students' success; however, students' motivation is an often-ignored aspect amongst the scholars of feedback perceptions.

The main insights in students' feedback perceptions in regard to students' learning strategies and students motivation would be following: (1) Positive feedback perceptions do not always result in improved learning; (2) Large class and relationships with instructors play an important role in developing certain feedback perceptions amongst students; (3) for student to apply instructional feedback, it is not enough for this feedback to be seen as useful, it is also important that student is able to recognize it and is willing to accept it; (4) students do not know how to utilize instructional feedback, even when students perceive feedback as useful and are willing to act on it.

6.3.3 Insights on instructors' feedback perceptions and feedback practices in large classes in Computer Science program

The overview of the literature in Chapter 5 shows the wide variety of challenges that instructors and teaching assistants of Computer Science face when crafting and providing appropriate feedback to students. These challenges impact the way how instructors and teaching assistants perceive feedback. Instructors and teaching assistants have limited influence on whether or not instructional feedback will be applied by students, however, instructors' beliefs about feedback are often reflected in feedback practices that are commonly utilized (Beaumont et al., 2011; Boud & Winstone, 2020). For example, our findings revealed that due to negative experience with changing feedback practices, limited resources available, large class and lack of expertise in developing appropriate feedback practices, instructors perceive feedback negatively. Commonly used feedback practices do not only impact students' feedback perceptions (van der Kleij et al., 2015), but might also significantly limit students' opportunities to act on feedback. In the study presented in Chapter 5 our findings reveal that grading was the preferred feedback practice amongst the instructors and teaching assistants. While not per se negative, grading does not involve in-progress reflections and adjustments of knowledge, neither it provides directions for improvement, which results amongst students in the lack of clarity on how to proceed with learning.

The main insight of the study presented in Chapter 5 would be the fact that instructors' negative experience with feedback and lack of expertise to develop appropriate feedback result in specific type of feedback practices being overused, even when this type of feedback practice proves to be ineffective for student learning. It is also important to acknowledge that not only students, but also instructors and teaching assistants require continuous support in developing, adjusting and implementing new feedback practices into the curriculum, especially when dealing with large classes, complex knowledge domains such as for example, Computer Science, and first semester as fundamental benchmark in establishing future directions in student learning.

6.5 Limitations and suggestions for future research

The research presented in this thesis has its limitations. The main limitation of this research is the sample size. Due to the small sample size, we cannot generalize our findings beyond this sample. Although these results may be potentially influential in terms of quality of instructional feedback, support and guidance provided to students, these results should be substantiated by other measurement instruments with larger sample size.

None of the chapters of this thesis have established the control groups or measurements at the end of students' program to compare the results to. Collecting data at the end of the program was not possible because of the Covid-19 guidelines that interfered with the 'normal' teaching and learning at the university. Establishing control groups was difficult since in educational research all students are given the same curriculum.

Another limitation is the use of self-report data from questionnaire and interpretations from students' group interviews. Students could provide false responses, self-select for participation in the interviews and questionnaires. It is possible that students who had positive experience with feedback and were utilizing effective learning strategies declined to participate, therefore their opinions are not included in this research.

Study into instructors' feedback perceptions might have been influences by volunteer bias as well.

The length of the questionnaire provided to students might have caused survey fatigue and low response rates, which are common amongst questionnaires and surveys that take longer than 15 minutes to complete (Porter et al., 2004).

A final limitation is related to reviews of all studies. All reviews included only the published articles. Publication bias state that articles that have negative results tend to be overlooked, while articles with positive results tend to be published (Mahoney, 1977). As a result, this research might not include the full spectrum of characteristics of feedback perceptions and the influence of feedback perceptions on students' learning.

Given the rapidly increasing interest in feedback perceptions, we believe that other measuring instruments, for example, observations, could substantiate our findings even further. Future studies into the dynamic interplay of characteristics of feedback perceptions can expand on this thesis in several ways. It could, for example, measure the influence of various factors on developing certain feedback perceptions amongst students. It could, also, measure to what extend instructors are able to influence students' feedback perceptions.
Since such aspect as students' motivation in conjunction with students' feedback perceptions is often neglected, we suggest that more studies are required to understand what aspects of motivation influence students' feedback perceptions and what aspects of feedback perceptions influence students' motivation to engage with feedback. Handley et al. (2011) established that students' willingness to accept instructional feedback results in students' drawn plan of actions towards applying this feedback. It might be useful to explore what aspects influence students' willingness to accept instructional feedback and to what extend it can be influenced.

More research on how exactly students use instructional feedback are needed. It is still not clear how exactly students engage with instructional feedback and how exactly students engage in certain learning strategies. It is also important to explore whether effective learning strategies are the result of specific feedback perceptions amongst students, and whether these feedback perceptions can be predicted.

6.6 Practical implications

The four studies in this dissertation yield several suggestions for instructors regarding feedback in large class during the transition period.

6.6.1 Encourage feedback on instructional feedback

Since the findings in Chapter 3 indicate that students' ability to recognize instructional feedback is a strong predictor of use of certain learning strategies, it is important to confirm that provided feedback is understood and accepted. For example, instructors might involve

students into design of feedback practices for the course, or ask for feedback on instructional feedback. Feedback sessions are also a common way to engage students into discussion on bridging the gap between the instructional feedback that is provided to students, and feedback that is used by students (Carroll, 1995). Students do not automatically recognize and accept instructional feedback, and results from study mentioned in Chapter 3 show benefits in confirming with students if provided feedback is clear. Additionally, instructors might involve students into discussion on what feedback is desired by students and make agreements on how to best deliver it for students to apply it. Even in the case of summative feedback, additional comments containing, for example, following steps in learning for students, should be clear, constructive and contain easy instructions to proceed in learning or revising the material (Nicol & Macfarlane-Dick, 2006).

6.6.2 Educate students about various learning strategies

The results of the study presented in Chapter 4 suggest that students often struggle with engaging with appropriate learning strategy that is effective for students learning. Bjork et al. (2013) claims that skills to operate with various learning strategies are not explicitly taught at the university, therefore we suggest that instructors inform students about different learning strategies and how to best use them. Examples to solve the given task is a good opportunity to guide students towards effective learning strategies. Another option is well-known Peer Instruction strategy (Mazur, Crouch, 2001). Additionally, instructors might suggest learning strategies that are appropriate for given assignments, tasks and exercises, by showing a step-by-step demonstration. In terms of Resource Management learning strategies, students should be made aware of the benefits of Planning and Scheduling, Peer Learning and Help Seeking learning strategies on students' learning. For example, instructors might invite students to collaborate on planning in-class activities for the course or discuss different learning strategies and ask for students' perceived effectiveness of each learning strategy.

6.6.3 Support instructors in developing and adapting feedback practices that fit the conditions of their learning environment

the study that is presented in Chapter 5 revealed that the program about pedagogical and educational competences, that all instructors and teaching assistants complete prior to teaching duties, is not enough for instructors who face various limiting conditions of learning environment. Such conditions might be, for example, a large class, or providing additional support during transition period. Heavy workload and limited resources lead instructors to fall back to well-known and convenient types to provide feedback with tangible result, for example, grading, even when such feedback practices are not effective and do not contribute to student learning. We suggest to provide opportunities for instructors to discuss appropriate feedback practices with a specialist, equipped in assessment research, who can help to take into account all the learning goals, limiting conditions and desires of students and instructors. Ideally, such opportunity should be a part of extension of the module Assess of the University Teaching Qualification, however, it is important that instructors still have an opportunity to consult the feedback specialist after the Qualification course – should that be needed later. Therefore, it is beneficial for each program offered within each faculty to have such specialist on-site at all times. Additionally, it is important to support instructors' knowledge about current innovations in assessment, therefore a potentially useful way to have instructors exchange their assessment knowledge is by using communities or groups of practice where instructors and assessment scholars can learn from each other.

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Appendices

Appendix A

Interview guide for student cohort of 2019/2020

Interview guide for first round of group interviews in September 2019

Research question: What feedback do the first-year bachelor students of the programme of Computer Science at Delft University of Technology receive?

Goal of the group interviews: create an image of perceptions[4] students get within the context of the first semester at CS program

Good afternoon, my name is Ljubov van Beek and I am doing research in the department of Computer Science about the feedback[5] that you get during your Reasoning and Logic course. The outcomes of this research will help the university to figure out what can support other students like you during their study in all three years and help to get through the process of learning at Delft University of Technology so everyone can learn and perform at their very best. I want to know how you experience Delft University of Technology – how do you feel in such a big group; in what way you think teachers are different from those you had at your secondary-school, and what do you think of your own progress?

I will be interviewing you for approximately one hour during which we will have a discussion about your experience here at Delft University of Technology, so feel free to say whatever you think is relative to the topic. This type of interview will take place three times during the

[4] The assumption is that some of the students are not familiar with the term "feedback", its scientific definition, or they perceive it differently from the researcher's perspective. I am interested in finding out what they see as feedback and that would give me an idea how can I help them develop towards self-regulated learners.

[5] Here I explicitly don't give students the definition of a feedback or any explanations that might lead to bias. However, it might happen that none of the students understand what feedback really is about, therefore I have prepared several sub-questions in the brackets following the first question)

reasoning and logic course – at the beginning – now, in the middle and at the end of the course. During this group interview you will get a free lunch provided as an appreciation for your contribution to my research.

I will begin with the first question and an assignment for this question. Here on a table, you can see a big sheet of paper with a word Feedback on it, your assignment is to write your answer on a sticky note and stick it anywhere on the paper.

1. What is feedback for you? What words pop up in your mind when I say feedback?

2. You have just started your study at the university and I assume the number of fellow students is much bigger than what you had at secondary school – how does it make you feel? What feelings and emotions you experience when you come into the classroom? Are they mostly negative or positive?

3. What differences did you notice in the way how teacher interacts or communicates with students here, compared to your secondary education experience? What do you think of these interactions?

4. How did you react when you received feedback at your secondary school? And what kind of feedback was it mostly? Was it up to your expectations or not? In what way did you use it for your learning progress?

5. What do you miss? Here at Delft University of Technology.

For today that was it. Thank you for your participation and time. If you have any questions about this project or just general question or idea – you can contact me via the email written on the whiteboard/blackboard. I hope you enjoyed your lunch. See you next time in October.

4. Interview guide for second round of group interviews in October 2019

Goal of the group interviews: to track the changes in experiences and expectations in terms of feedback and study behaviour over the course

Good afternoon, today it's our second round of interviews and we will be taking about the experiences that you have acquired so far during the course. Now, when you are further in your studies you start getting used to the new environment, teaching ways and working on your learning. Today I will be asking you mostly about your experience so far and about you plans and expectations. And of course, you can enjoy your lunch in the meantime.
So, let's start with the first question:

1. What is feedback for you? What words/feelings pop up in your mind when I say Feedback?

2. How do you feel now in your classroom (how is the atmosphere in the classroom)? Do you feel seen or unseen? Name three things that you like about studying in such a big group and three things that you dislike. (on post-it's on a big sheet of paper)

3. What do you do to get the teacher's attention when you need it? And what about your fellow students? Teaching assistants? (can you easily get their attention too?)

4. Can you describe the situation when it was hard to get help/answer your question/clarify something and what did you do to fix it? How different it is from your secondary school? In what way exactly?

5. What is the biggest challenge in learning you have faced so far? How have you dealt with this challenge?

6. How do you plan your work? Are you able to stick to your planning?

7. What is your experience with studying here at Delft University of Technology so far? Is it more or less the same as you expected in the beginning of the course? If not, what is different?

8. Is there anything that still needs to be discussed? Or anything that you want to bring in still?

9. What do you miss? (Here at Delft University of Technology: in terms of learning, feedback, communication/interaction or anything else)

Thank you for your today – I have all the answers I need and I will see you for our last round of interviews in the end of the course right before Christmas holidays in December. Once again, if you have any questions about this project or just general question or idea – you can contact me via the email written on the whiteboard/blackboard.

5. Interview guide for third round of group interviews in November/December 2019

Goal of the group interviews: to evaluate students' experience at the end of the course, to look back on what they liked and what they disliked in terms of feedback they received during the course and how they used it for their studies

Welcome back to our third and last interview session. Thank you for your time and effort – you are giving so much contribution to my research. Today, as always, we do our one-hour round of interviews together with lunch, and then you are completely free for the rest of your study. Let's begin.

I would like to start with the question I asked you in the beginning of our interview sessions:

1. What is feedback for you? How would you describe it now? Did your understanding of it changed compared when I first asked this question? How?

2. Now the course is almost finished – how do you feel the atmosphere in the classroom changed? Do you feel differently now than in the beginning of the course? What did you personally do to change it?

3. Was it always possible to get your teachers' attention? Were you encouraged to ask questions during the class? How did you participate in the discussions? (if not- why not?)

4. Can you describe the situation when you receive the feedback totally opposite to what you expected? Was it positive or negative? How did you react?

5. What feedback do you see as the most useful for yourself – from you teacher/ peers/ teaching assistants or your own reflection? And why?

6. What is your definition of a successful student? What do you need to do to achieve that?

And the last question for the entire interview sessions:

7. How the feedback you received during the course helped you to prepare for the exams?

Thank you very much for being here and discussing all these questions with me. I appreciate your time and effort and I am very happy you agreed to help me in this matter. Enjoy your day and if you have any questions about this project or just general question or idea – you can contact me via the email written on the whiteboard/blackboard. Once again, enjoy your day and your study here at TU Delft.

Appendix B

Interview guides

1. Interview guide for instructors and TAs, involved in teaching and evaluating first-year bachelor students of Computer Science programme

Interview guide for the semi-structured individual interviews in February/March 2020

Goal of the interviews: the interview aims to explore how instructors and TA's perceive instructional feedback

Good afternoon, my name is Ljubov van Beek and I am doing research in the department of Computer Science. This research is sponsored by Delft University of Technology and Centre of Engineering Education. The goal of this interview is to explore the intended goals teachers have when providing feedback to the first-year bachelor students at the department of Computer Science. It also aims to explore how do teachers of Computer Science department facilitate learning in a large class. For that case I have decided to interview all teachers of Computer Science department who teach first-year bachelor students.

The overall goal of the research is to figure out what can support students in large classes during their study in all three years and help to get through the process of learning at Delft University of Technology so everyone can learn and perform at their very best.

The interview will be audio-recorded and further transcribed. The interview is anonymous and it will be kept secure in the SurfDrive, protected by a password. You can request to see transcriptions of your own interview only at any time in two-three weeks after our interview took place. The outcomes and findings of the interview will be used in writing and publishing scientific articles, presenting in conferences.

I will be interviewing you for approximately one hour during which I will ask you several questions related to feedback, large classes and teaching goals, so feel free to say whatever you think is relative to the topic.

Let's start with the first question:

1. What is feedback for you? How do you describe feedback in your own words?
    a. What type(s) of feedback do you provide for your course? What is the main goal(s) of that feedback?

2. When providing feedback for written assignment or exam – what do you typically focus on?

3. What do you want your students to do with the feedback you provide? Both for home assignments and exams.
    a. Do you think your goal is achieved? Why do you think so?

4. What do you think your students want from your feedback?

5. All that we discussed before about feedback – in what way do you include it in your classes to facilitate learning?

Appendix C

Motivated Strategies for Learning subscales:

Motivation Category:

1. **Value Component: Intrinsic Goal Orientation**

Intrinsic Goal Orientation scale includes students' perception of the reasons to engage in learning.

2. **Value Component: Extrinsic Goal Orientation**

Extrinsic Goals Orientation scale includes students' perception of the rewards for engaging in learning.

3. **Value Component: Task Value**

Task Value scale includes students' perception of the course in terms of interest, importance and utility.

4. **Expectancy Component: Control of Learning Beliefs**

Control of Learning Beliefs scale reports students' beliefs about one's effort in contingent to one's results.

5. **Expectancy Component: Self-Efficacy for Learning and Performance**

Self-Efficacy for Learning and Performance scale reports of personal judgements of one's ability to complete the task as well as one's confidence in the process.

6. **Affective Component: Test Anxiety**

Test Anxiety scale includes students' cognitive concerns and worries about the performance.

Learning Strategies category:

7. Cognitive and Metacognitive Strategies: Rehearsal

Rehearsal as a learning strategy that includes repetition and activating information in working memory (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990). High scores in this scale indicate students' ability to remember and reproduce information.

8. Cognitive and Metacognitive Strategies: Elaboration.

Elaboration as a learning strategy is focused on storing information into long-term memory and connecting new information to prior information (MSLQ Manual, 2015; McKeachie,

Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990).

9. Cognitive and Metacognitive Strategies: Organization

Organization learning strategies help students organize information and knowledge (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990).

Low scores in this dimension indicate that students struggle organizing new material and knowledge.

10. Cognitive and Metacognitive Strategies: Critical Thinking

Critical thinking is a learning strategy indicates students' ability to reflect on prior knowledge in terms of solving new problems and making new decisions (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990).

11. Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation

Metacognitive Self-Regulation learning strategies assume students' accountability in one's learning process: awareness, knowledge and control of cognition as well as regulating oneself behaviour to improve performance and learning (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990). Low scores in this dimension indicate that students struggle recognizing this learning strategy as a way they learn.

12. **Resource Management: Time and Study Environment**

Time and Study environment management learning strategy helps students to plan, schedule and set realistic goals in learning (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990). High scores in this scale indicate students' ability to plan studying time ahead, schedule activities and set realistic goals (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990).

13. **Resource Management: Effort Regulation**

Resource management strategies are learning strategies aimed on organizing and managing resources available to students (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990).

Effort regulation learning strategy supports students to control oneself effort and attention (MSLQ Manual, 2015).

14. **Resource Management: Peer Learning**

Peer Learning, as a resource management strategy, inclines collaborating with fellow students from the class (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990). High scores in this scale indicate students' ability to collaborate with fellow students.

15. **Resource Management: Help Seeking**

Peer Learning, as a resource management strategy, is similar to Peer Learning but on a bigger scale: it inclines students' ability to search and find assistance and support when needed (MSLQ Manual, 2015; McKeachie, Pintrich, Lin & Smith, 1986; Pintrich, 1988; Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & DeGroot, 1990). High scores in this scale indicate students' ability to seek and find appropriate help, support or assistance when required.

Appendix D

Instructional Feedback Orientation Scale subscales:

1. Feedback Utility

Feedback utility represents attitudes towards how useful and applicable feedback is perceived by students (King et al., 2009). Students who score high in this scale perceive feedback as useful, important and valuable (King et al., 2009).

2. Feedback Sensitivity

Feedback sensitivity represents students' attitudes towards feedback as a tool to improve learning as opposed to judgements of personal attributes (King et al., 2009). Students who score high on this scale tend to see feedback as threatening, embarrassing or intimidating (King et al., 2009).

3. Feedback Confidentiality

The Feedback Confidentiality scale reports on students' attitudes towards frames of reference when feedback is received in regards with students' privacy or publicity (King et al., 2009). In other words – whether students prefer to receive instructional feedback publicly or privately. Students who scored high in this scale, tend to perceive feedback appropriate if it is given in private (King et al., 2009).

4. Feedback Retention

Feedback Retention scale reports of students' ability to remember instructional feedback that they receive (King et al., 2009). Low scores in this scale mean that students are able to remember and hold onto provided feedback (King et al., 2009).

Appendix E

IFOS analysis results per item per scale

Feedback dimension	Students' feedback perception	Mean	Std. deviation	Median
Feedback utility	Feedback from teachers is a waste of time	5.23	0.979	5.00
	I listen carefully when an instructor provides feedback	5.04	0.904	5.00
	I pay careful attention to the feedback that instructor gives	4.94	0.917	5.00
	I am extremely encouraged by positive feedback from instructors	4.88	1.044	5.00
	Feedback from my instructor can be a valuable form of praise	4.81	0.981	5.00
	I think that feedback provides clear directions on how to improve my performance	4.69	1.166	5.00
	Feedback from my instructor motivated me to improve my performance	4.61	1.041	5.00
	I will usually reflect on instructor's feedback	4.5	1.235	5.00
Feedback sensitivity	It is difficult to 'get over' corrective feedback	4.99	1.087	5.00
	My feelings are not easily hurt by corrective feedback from an instructor	4.51	1.317	5.00
	Corrective feedback is embarrassing	2.66	1.337	2.00
	I tend to dwell on the negative feelings that result from corrective feedback	2.65	1.337	2.00
	Corrective feedback from an instructor increases the stress I feel about future performance	2.53	1.297	2.00
	My feelings can be easily hurt by corrective feedback from an instructor	2.31	1.199	2.00
	Corrective feedback is intimidating	2.19	1.217	2.00
	I feel threatened by corrective feedback	2.09	1.130	2.00
	Corrective feedback hurts my feelings	2.06	1.049	2.00

Feedback Confidentiality	I prefer to receive feedback from an instructor in private	4.26	1.342	4.00
	I like others to hear the feedback I am receiving from my instructor	4.18	1.167	4.00
	I don't mind being singled out by feedback from an instructor	3.68	1.378	3.00
	I do not like to receive corrective feedback in front of other people	3.47	1.649	4.00
	I do not like for others to hear what feedback I am receiving	3.32	1.517	3.00
Feedback Retention	I typically do not make note of the instructor's corrective comments	2.81	1.257	3.00
	I tend to miss out on the details of what instructors want when they provide me feedback	2.79	1.162	3.00
	I can't remember what instructors want me to do when they provide feedback	2.56	1.070	2.00

Appendix F

MSLQ analysis results per item per scale

Motivated Strategies for Learning Questionnaire Scale	Students' motivation	Mean	Std. deviation	Median
Self-Efficacy for Learning and Performance	I'm confident I can understand the basic concepts taught in this course	5.19	0.802	5.00
	I'm certain I can master the skills being taught in this course	4.53	0.970	5.00
	I expect to do well in this course	4.40	0.917	4.00
	Considering the instructor, my skills and the difficulty of this course, I think I will do well in this course	4.39	0.840	4.00
	I'm confident I can do an excellent job on the assignments and tests in this course	4.10	1.116	4.00
	I'm certain I can understand the most difficult material presented in the readings for this course	4.06	1.278	4.00
	I'm confident I can understand the most complex material presented by the instructor in this course	4.04	1.246	4.00
	I believe I will receive an excellent grade in this course	3.61	1.056	4.00
Control of Learning Beliefs	If I study in appropriate ways, I will be able to learn the material in this course	5.16	0.773	5.00
	If I try hard enough, then I will understand the course material	5.07	0.879	5.00
	It is my own fault if I don't learn the material in this course	4.99	0.922	5.00
	If I don't understand the course material, it is because I didn't try hard enough	4.44	1.258	5.00
Task value	It is important for me to learn the course material in this class	4.95	0.927	5.00
	I think the course material in this course is useful for me to learn	4.72	0.946	5.00

	I think I will be able to use what I learn in this course in other courses	4.70	0.844	5.00
	I like the subject matter of this course	4.65	1.006	5.00
	I am very interested in the content area of this course	4.53	1.214	5.00
	Understanding the subject matter of this course is very important to me	4.50	1.135	5.00
Intrinsic goal orientation	In a course like this, I prefer course material that arouses my curiosity even if it is difficult to learn	4.69	1.082	5.00
	In a class like this I prefer course material that really challenges me so I can learn new things	4.43	1.079	5.00
	The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible	4.32	0.953	4.00
	When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade	4.17	1.196	4.00
Extrinsic goal orientation	If I can, I want to get better grades in this course than most of the other students	4.48	1.187	5.00
	The most important thing for me tight now is improving my average grade, so my main concern in this course is getting a good grade	3.96	1.134	4.00
	Getting a good grade in this course is the most satisfying thing for me right now	3.89	1.349	4.00
	I want to do well in this course because it is important to show my ability to my family, friends, employer or others	3.69	1.504	4.00
Test anxiety	When I take tests, I think of the consequences of failing	4.29	1.409	4.00
	When I take a test, I think about items on other parts of the test I can't answer	3.81	1.323	4.00

	I have an uneasy, upset feeling when I take an exam	3.43	1.392	3.00
	I feel my heart beating fast when I take an exam	3.39	1.593	3.00
	When I take a test, I think about how poorly I am doing compared to other students	3.22	1.474	3.00
Cognitive & Metacognitive Learning Strategies Scale	**Students' learning Strategy**	**Mean**	**Std. deviation**	**Median**
Elaboration	When reading for this course, I try to relate the material to what I already know	4.68	1.082	5.00
	I try to relate ideas in this subject to those in other courses whenever possible	4.48	1.026	5.00
	When I study for this course, I pull together information from different sources, such as lectures, readings and discussions	4.45	1.107	5.00
	I try to understand the material in this course by making connections between the readings and the concepts from the lectures	4.34	1.043	4.00
	I try to apply ideas from course readings in other class activities such as lecture and discussion	4.04	1.156	4.00
	When I study for this course, I write brief summaries of the main ideas from the readings and my lecture notes	3.46	1.559	4.00
Metacognitive Self-Regulation	When I become confused about something I'm reading for this course, I go back and try to figure it out	4.85	0.722	5.00
	When Studying for this course, I try to determine which concepts I don't understand well	4.54	0.963	5.00

	When I study for this course, I set goals for myself in order to direct my activities in each study period	4.13	1.097	4.00
	If I get confused taking notes during the lecture, I make sure I sort it out afterwards	4.09	1.360	4.00
	I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course	4.06	1.065	4.00
	Before I study new course material thoroughly, I often skim it to see how it is organized	3.83	1.378	4.00
	If course readings are difficult to understand, I change the way I read the material	3.78	1.122	4.00
	I try to change the way I study in order to fit the course requirements and instructor's teaching style	3.78	1.257	4.00
	I often find that I have been reading for this course but don't know what it was all about (reverse-coded)	3.70	1.437	4.00
	I ask myself questions to make sure I understand the material I have been studying in this course	3.65	1.254	4.00
	During class time I often miss important points because I'm thinking of other things (reverse-coded)	3.30	1.495	3.00
	When reading for this course, I make up question to help focus my reading	3.07	1.462	3.00
Organization	When I study for this course, I go through the readings and my lecture notes and try to find the most important ideas	4.24	1.243	4.00
	When I study for this course, I go over my lecture notes and make an outline of important concepts	3.58	1.507	4.00

	When I study the readings for this course, I outline the material to help me organize my thoughts	3.36	1.540	4.00
	I make simple charts, diagrams, or tables to help me organize course material	3.14	1.449	3.00
Critical Thinking	I try to play around with ideas of my own related to what I am learning in this course	4.11	1.222	4.00
	I treat the course material as a starting point and try to develop my own ideas about it	3.80	1.177	4.00
	Whenever I read or hear an assertion or conclusion in this course, I think about possible alternatives	3.66	1.108	4.00
	When a theory interpretation, or conclusion is presented in course or in the readings, I try to decide if there is good supporting evidence	3.49	1.177	3.00
	I often find myself questioning things I hear or read in this course to decide if I find them convincing	3.37	1.218	3.00
Rehearsal	I memorize key words to remind me of important concepts in this course	3.88	1.400	4.00
	When studying for this course, I read my lecture notes and the course readings over and over again	3.60	1.457	4.00
	I make lists of important items for this course and memorize the lists	3.23	1.441	3.00
	When I study for this course, I practice saying the material to myself over and over again	2.78	1.506	3.00
Effort Regulation	When course work is difficult, I either give up or only study the easy parts (reverse-coded)	4.39	1.274	5.00
	I work hard to do well in this course even if I don't like what we are doing	4.08	1.143	4.00

		Even when course materials are dull and uninteresting, I manage to keep working until I finish	4.06	1.314	4.00
		I often feel so lazy or bored when I study for this course, that I quit before I finish what I planned to do (reverse-coded)	3.90	1.389	4.00
Time and Study Environment		I attend this course regularly	4.72	1.554	5.00
		I usually study in a place where I can concentrate on my course work	4.60	0.115	5.00
		I rarely find time to review my notes or readings before an exam	4.21	1.408	5.00
		I often find that I don't spend very much time on this course because of other activities (reverse-coded)	3.94	1.303	4.00
		I make sure that I keep up with the weekly readings and assignments for this course	3.94	1.334	4.00
		I make good use of my study time for this course	3.93	1.097	4.00
		I have a regular place set aside for studying	3.86	1.421	4.00
		I find it hard to stick to a study schedule (reverse-coded)	2.94	1.417	3.00
Peer Learning		I try to work with other students from this course to complete the course assignments	4.07	1.350	4.00
		When studying for this course, I often try to explain the material to a classmate or friend	3.66	1.421	4.00
		When studying for this course, I often set aside time to discuss course material with a group of students from the course	2.73	1417	2.00
Help Seeking		When I can't understand the material in this course, I ask another student in this class for help	3.99	1.297	4.00

I try to identify students in this course whom I can ask for help if necessary	3.68	1.498	4.00
Even if I have trouble learning the material in this course, I try to do the work on my own, without help from anyone (reverse-coded)	2.97	1.278	3.00
I ask the instructor to clarify concepts I don't understand well	2.91	1.416	3.00

Appendix G

Cronbach's alpha values per scales

MSLQ

MSLQ scales	α
Value Component: Intrinsic Goal Orientation	0.715
Value Component: Extrinsic Goal Orientation	0.583
Value Component: Task Value	0.880
Expectancy Component: Control of Learning Beliefs	0.753
Expectancy Component: Self-Efficacy for Learning and Performance	0.908
Affective Component: Test Anxiety	0.797
Cognitive and Metacognitive Strategies: Rehearsal	0.721
Cognitive and Metacognitive Strategies: Elaboration	0.793
Cognitive and Metacognitive Strategies: Organization	0.788
Cognitive and Metacognitive Strategies: Critical Thinking	0.781
Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation	0.714
Resource Management: Time and Study Environment	0.762
Resource Management: Effort Regulation	0.717
Resource Management: Peer Learning	0.652
Resource Management: Help Seeking	0.576
IFOS sub-scales	
Feedback Utility	0.903
Feedback Sensitivity	0.806
Feedback Confidentiality	0.805
Feedback Retention	0.909

α – Cronbach's alpha values

Appendix H

The combined questionnaire (The Motivated Strategies for Learning Questionnaire, the Instructional Feedback Orientation Scale and questions related to students' general information). Adapted from the original copy sent via Qualtrics.

Dear Participant,

You are invited to participate in a study titled **Feedback for Self-Regulated Learning in Large classes**.

Studying in a large class has its pros – you get to know a lot of new people and socialize while at the same time it may come with challenges – it might be difficult to ask questions or get help. The aim of this research is to explore what can be done to support students in the process of learning in such a large class. For that reason, it is important to know what students find motivating and learn how students use provided feedback.

The aim of this questionnaire is to identify the challenges that you encounter during your first semester studying the Computer Science program, and gain insight on your experiences studying in a large class.

The questionnaire consists of three parts: 1. The first part is general information about you; 2. The second part is 81 questions regarding your motivation and learning strategies; and 3. The third part is 27 questions related to your perception of instructional feedback.

Your participation in this study is entirely voluntary and you can withdraw at any time. The data will be used for research purposes and quality improvement only. It will be stored and kept according to the Delft University of Technology privacy laws. To minimize the risks and to protect your data – we ask you to sign a consent form that can be found here [link].

The questionnaire is in total 108 questions. It will take you about 15 minutes to complete the questionnaire.

There will be a lottery amongst all the participants who completed the questionnaire with a prize of 20€ gift card from bol.com

Your answers are very important for my research. They can really make a difference for teaching and learning in large classes at Delft University of Technology.

Thank you for cooperation!

Questionnaire items:

Age:

Gender:

The highest level of education you have completed so far: [International Baccalaureate; Dutch VWO; Undergraduate degree (Bachelor's); Dutch HBO; Dutch WO; Other, namely:]

Based on previous question, in what country did you get this degree:

At secondary school/high school, what were your grade for Math's:

The Motivated Strategies for Learning part. Statements are evaluated from 1 = 'very untrue of me to 6 = 'very true of me'.

1. In a class like this I prefer course material that really challenges me so I can learn new things
2. If I study in appropriate ways, I will be able to learn the material in this course
3. When I take tests, I think of the consequences of failing
4. I think I will be able to use what I learn in this course in other courses
5. I believe I will receive an excellent grade in this course
6. I'm certain I can understand the most difficult material presented in the readings for this course
7. Getting a good grade in this course is the most satisfying thing for me right now
8. When I take a test, I think about items on other parts of the test I can't answer
9. It is my own fault if I don't learn the material in this course
10. It is important for me to learn the course material in this course

11. The most important thing for me tight now is improving my average grade, so my main concern in this course is getting a good grade
12. I'm confident I can understand the basic concepts taught in this course
13. If I can, I want to get better grades in this course than most of the other students
14. When I take tests, I think of the consequences of failing
15. I'm confident I can understand the most complex material presented by the instructor in this course
16. In a course like this, I prefer course material that arouses my curiosity even if it is difficult to learn
17. I am very interested in the content area of this course
18. If I try hard enough, then I will understand the course material
19. I have an uneasy, upset feeling when I take an exam
20. I'm confident I can do an excellent job on the assignments and tests in this course
21. I expect to do well in this course
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible
23. I think the course material in this course is useful for me to learn
24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade
25. If I don't understand the course material, it is because I didn't try hard enough
26. I like the subject matter of this course
27. Understanding the subject matter of this course is very important to me
28. I feel my heart beating fast when I take an exam
29. I'm certain I can master the skills being taught in this course
30. I want to do well in this course because it is important to show my ability to my family, friends, employer or others
31. Considering the instructor, my skills and the difficulty of this course, I think I will do well in this course

32. When I study the readings for this course, I outline the material to help me organize my thoughts
33. During class time I often miss important points because I'm thinking of other things
34. When studying for this course, I often try to explain the material to a classmate or friend
35. I usually study in a place where I can concentrate on my course work
36. When reading for this course, I make up question to help focus my reading
37. I often feel so lazy or bored when I study for this course, that I quit before I finish what I planned to do
38. I often find myself questioning things I hear or read in this course to decide if I find them convincing
39. When I study for this course, I practice saying the material to myself over and over again
40. Even if I have trouble learning the material in this course, I try to do the work on my own, without help from anyone
41. When I become confused about something I'm reading for this course, I go back and try to figure it out
42. When I study for this course, I go through the readings and my lecture notes and try to find the most important ideas
43. I make good use of my study time for this course
44. If course readings are difficult to understand, I change the way I read the material
45. I try to work with other students from this course to complete the course assignments
46. When studying for this course, I read my lecture notes and the course readings over and over again
47. When a theory interpretation, or conclusion is presented in course or in the readings, I try to decide if there is good supporting evidence
48. I work hard to do well in this course even if I don't like what we are doing
49. I make simple charts, diagrams, or tables to help me organize course material
50. When studying for this course, I often set aside time to discuss course material with a group of students from the course
51. I treat the course material as a starting point and try to develop my own ideas about it

52. I find it hard to stick to a study schedule
53. When I study for this course, I pull together information from different sources, such as lectures, readings and discussions
54. Before I study new course material thoroughly, I often skim it to see how it is organized
55. I ask myself questions to make sure I understand the material I have been studying in this course
56. I try to change the way I study in order to fit the course requirements and instructor's teaching style
57. I often find that I have been reading for this course but don't know what it was all about
58. I ask the instructor to clarify concepts I don't understand well
59. I memorize key words to remind me of important concepts in this course
60. When course work is difficult, I either give up or only study the easy parts
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course
62. I try to relate ideas in this subject to those in other courses whenever possible
63. When I study for this course, I go over my lecture notes and make an outline of important concepts
64. When reading for this course, I try to relate the material to what I already know
65. I have a regular place set aside for studying
66. I try to play around with ideas of my own related to what I am learning in this course
67. When I study for this course, I write brief summaries of the main ideas from the readings and my lecture notes
68. When I can't understand the material in this course, I ask another student in this class for help
69. I try to understand the material in this course by making connections between the readings and the concepts from the lectures
70. I make sure that I keep up with the weekly readings and assignments for this course
71. Whenever I read or hear an assertion or conclusion in this course, I think about possible alternatives

72. I make lists of important items for this course and memorize the lists
73. I attend this course regularly
74. Even when course materials are dull and uninteresting, I manage to keep working until I finish
75. I try to identify students in this course whom I can ask for help if necessary
76. When Studying for this course, I try to determine which concepts I don't understand well
77. I often find that I don't spend very much time on this course because of other activities
78. When I study for this course, I set goals for myself in order to direct my activities in each study period
79. If I get confused taking notes during the lecture, I make sure I sort it out afterwards
80. I rarely find time to review my notes or readings before an exam
81. I try to apply ideas from course readings in other class activities such as lecture and discussion

The Instructional Feedback Orientation Scale part. Statements are evaluated from 1 = 'strongly disagree' to 6 = 'strongly agree'.

82. I think feedback from instructors is vitally important in improving my performance.
83. I will usually reflect on instructor's feedback
84. I listen carefully when an instructor provides feedback
85. I am extremely encouraged by positive feedback from instructors
86. I think that feedback provides clear directions on how to improve my performance
87. Feedback from my instructor can be a valuable form of praise
88. I pay careful attention to the feedback that instructor gives
89. Feedback from my instructor motivates me to improve my performance
90. Feedback from teachers is a waste of time
91. I feel relieved when I receive positive feedback
92. My feelings can be easily hurt by corrective feedback from an instructor
93. I feel threatened by corrective feedback

94. Corrective feedback hurts my feelings

95. Corrective feedback is intimidating

96. It is difficult to 'get over' corrective feedback

97. My feelings are not easily hurt by corrective feedback from an instructor

98. Corrective feedback is embarrassing

99. I tend to dwell on the negative feelings that result from corrective feedback

100. Corrective feedback from an instructor increases the stress I feel about future performance

101. I do not like to receive corrective feedback in front of other people

102. I do not like for others to hear what feedback I am receiving

103. I don't mind being singled out by feedback from an instructor

104. I prefer to receive feedback from an instructor in private

105. I like others to hear the feedback I am receiving from my instructor

106. I can't remember what instructors want me to do when they provide feedback

107. I tend to miss out on the details of what instructors want when they provide me feedback

108. I typically do not make note of the instructor's corrective comments

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Curriculum Vitae

Ljubov van Beek

2018 – 2024	PhD Candidate Conducting research project aimed to investigate first-year students' feedback perceptions in the context of large class in Computer Science Education PhD thesis titled 'The medium is the message: Investigating feedback perceptions in large Computer Science Education classes'	Department of Science Education and Communication, Delft University of Technology
2014 – 2016	Master of Arts in Education cum laude resulting in an MA degree cum laude in Education and CLIL teacher qualification (Qualification in Content and Language Integrated Learning – CLIL, first-degree qualification) Master thesis titled 'Multiple intelligences activities in CLIL lessons of mathematics in English at upper secondary school: students' involvement and learning outcomes'	Faculty of Social Sciences, Department of Humanities, Tartu University, Narva College, Estonia
2009 – 2013	Bachelor of Arts in Education resulting in a BA degree and CLIL teacher qualification (second-degree qualification) Bachelor thesis titled 'The language immersion in Estonia: a copy of the Canadian model or one of its own kind?'	Faculty of Social Sciences, Department of Humanities, Tartu University, Narva College, Estonia
1996 – 2008	Secondary school	Sillamäe Astangu School, Sillamäe, Estonia
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List of publications and presentations

Scientific Publications

van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. (Under revision). Facilitating learning in Computer Science education: Instructors' feedback perceptions and feedback practices in large classes.

van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. (Under revision). Towards better understanding of instructional feedback application: mixed-method study.

van Beek, L., van den Bogaard, M. E. D. (accepted). Feedback in large Computer Science classes: exploring students' instructional feedback perceptions and association with students' learning strategies.

van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. (2021). Feedback perceptions: preliminary analysis of semi-structured group interviews with first-year bachelor students of Computer Science, 2021 IEEE Frontiers in Education Conference (FIE), Lincoln, NE, USA, 2021, pp. 1-8, doi: 10.1109/FIE49875.2021.9637295

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Nikonova, L. (2013). The language immersion in Estonia: a copy of the Canadian model or one of its own kind? [Bachelor thesis], available at https://hdl.handle.net/10062/32573

Paper and poster presentations

Van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. (2018, 29-31 August). Feedback for learning in large classes [Poster presentation]. 9th biennial EARLI SIG 1: Assessment & Evaluation Conference, Helsinki, Finland

Van Beek, L., van den Bogaard, M. E. D., de Vries, M. J. (2021, 12 September). Feedback for Learning in large classes in Computer Science education [Paper presentation in symposium]. European Society of Engineering Education (SEFI) Doctoral Symposium in Engineering Education Research 2021, online.

Van Beek, L., Klaassen, R. G., M. E. D., de Vries, M. J. (2018, 17-23 September). Feedback for Learning in large classes in Computer Science education [Poster presentation]. European Society of Engineering Education (SEFI) 46th Annual Conference, Copenhagen, Denmark