

MASTER THESIS

STUDENTS' PERCEPTIONS ON ONLINE CHALLENGE-BASED LEARNING: PATTERNS AND PERFORMANCE

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Abstract

Collaborative learning in the form of challenge-based learning is a popular instructional method used to teach students how to work together. However, the challenge is to devise compelling strategies that encourage and support students to engage in meaningful learning experiences. Our research aims to study students' perceptions in relation to group-performance levels, in order to identify the perceptions' change patterns and indicators of less successful groups in online challenge-based learning. Our research consists of two experiments involving 13 teams of university students. We applied Volet's (2001) Student Appraisal of Group Assignments (SAGA) instrument to measure students' perceptions on six constructs: *Cognitive Benefits*, *Motivation Influence*, *Affect*, *Interpersonal*, *Management*, and *Group Assessment*. Questionnaires were administered at different time points (*before*, *during*, and *after* the project). Focus groups were conducted to gain insights into students' experiences. Our findings suggest that students reporting decreasing or stalling perception scores on *Motivation Influence* and *Interpersonal* constructs would likely not be in high-performing groups. Additionally, challenge-based learning is less suitable for time-compressed courses. The study expands our understanding of students' perceptions on online challenge-based learning, at different performance levels, and difficulties in these projects. Practical implications of this study are suggestions for teachers in identifying struggling teams, and designing and facilitating challenge-based courses.

Keywords: students' perceptions, challenge-based learning, online project courses, online challenge-based courses, challenge-based projects

Introduction

Teamwork skills are highly regarded by employers (Deloitte, 2018; Somerville, 2019). Unfortunately, most graduates, lack the teamwork skills required in professional environments (Deloitte, 2018; Somerville, 2019). To prepare students for their professional careers, more bachelor and master programmes include collaborative learning as an instructional strategy to equip students with the groupwork experience (Nam & Zellner, 2011). Collaborative learning for example is implemented in challenge-based learning courses where students are invited to work on real-life problems in small teams to practice work-related skills and work on relevant cases (Malmqvist, Radberg, & Lundqvist, 2015).

Next to equipping students with workplace skills, collaborative learning has various cognitive and psychological benefits and requirements (Järvelä, Volet, & Järvenoja, 2010). Externalizing task-related ideas can stimulate cognitive restructuring and enhance learning. Moreover, through externalizing ideas, team members might obtain new knowledge and get acquainted with alternative perspectives (Hall, Palmer, & Bennett, 2012; Suryanti & Supeni, 2019; Wolff, 2003; Zhang, Peng, & Hung, 2009). To create a successful collaborative experience, students must understand the task at hand. An understanding of the available knowledge and skills in the team is needed to identify strengths, weaknesses, and knowledge gaps related to the task. Next to these cognitive requirements, students are required to engage in social and communicative processes to reach a shared understanding of the tasks, processes, and actions during groupwork (Almulla, 2020). This allows team members to coordinate actions and build on each other's knowledge to attain a shared goal.

However, it is often difficult to design tasks and contexts that encourage the students to engage in the cognitive and social processes that ensure the team learning activities meet their full potential (Chang & Brickman, 2018; Fiechtner & Davis, 1984; Phunaploy, Chatwattana, & Piriyasurawong, 2021; Roberts & McInerney, 2007; Suryanti & Supeni, 2019). The challenges of collaborative learning are also reflected in students' opinions about collaborative tasks. Research indicates that students are not often positive about collaborative tasks; they report frustrations over teamwork and perceive it as a time-consuming activity with little cognitive benefit (Capdeferro & Romero, 2012; Chang & Brickman, 2018; Fiechtner & Davis, 1984). These negative experiences prevent students from fully engaging in teamwork activities. In the worst case, the success of a team might be threatened by members that do not collaborate or that engage in social loafing. These negative experiences get exacerbated in online settings (Ng, 2001; Ragoonaden & Bordeleau, 2000). The exacerbation can be explained by the fact that in online settings, it takes a longer time for students to recognize the undesired and unpleasant behavior that negatively affects the group performance (Roberts & McInerney, 2007; Simon & Stauber, 2011). Also, individual students' perceptions, prior

knowledge related to teamwork, and the specifics of the task at hand remain unclear for longer (Roberts & McInerney, 2007). This makes it more difficult for students to coordinate and manage the actual work, which might negatively influence students' perceptions related to teamwork.

The above-mentioned challenges might apply even more for collaboration tasks in the context of challenge-based learning. It is because challenge-based learning places high demands on students' planning and coordination skills (Almulla, 2020; Bilbao, Varela, Rebollar, Bravo, & García, 2018). Challenge-based learning is highly self-organized; and students are responsible for setting up team meetings, planning, and monitoring the work (Bilbao et al., 2018). Negative experiences early in the teamwork process, for example with creating a shared understanding of the task or planning work, might affect students' perceptions about and attitudes towards groupwork at later stages.

Although research has been conducted about students' groupwork process in face-to-face settings (Brandyberry & Bakke, 2006; Capdeferro & Romero, 2012), there is little research on students' perceptions about groupwork in online settings (Koh & Hill, 2009), and even less about projects that are highly self-regulated as is the case in challenge-based learning (Bilbao et al., 2018; Gallagher & Savage, 2020; Leijon, Gudmundsson, Staaf, & Christersson, 2021). Very little is currently known about how students' perceptions change in online challenge-based learning (Leijon et al., 2021). The relation between students' perceptions and group performance levels in online challenge-based learning remains unclear. Hence, it is necessary to investigate more about students' perceptions in relation to various group performance levels in order to recognize changes, and consequently, help notice potentially less successful groups. This supports teachers in identifying and providing prompt guidance to students in the collaboration process. This research aims to explore students' perceptions during online challenge-based learning in relation to group performance levels.

Theoretical framework

Challenged-based learning

Challenge-based learning is often taken as a task for collaborative learning. Students can learn from the dynamic and reciprocal interaction among people, environment, and behavior (Bandura, 1989; Hall et al., 2012; Phunaploy et al., 2021; Suryanti & Supeni, 2019; Requies, Agirre, Barrio, & Graells, 2018; Wolff, 2003; Zhang et al., 2009). In challenge-based learning, students are given a real-life problem to solve (Malmqvist et al., 2015). Also, students could involve industry experts as the stakeholder in working on the solution for the problem (Malmqvist et al., 2015). With the key presence of stakeholders, students would receive feedback on their work and together find the most relevant solution for the problem (Ibwe, Kalinga, Mvungi, Tenhunen, & Taajamaa, 2018). From working on the

problem together, students are expected to become independent learners, critical thinkers, problem solvers, and team players (Lehtinen, 2003; Malmqvist et al., 2015).

Moreover, when collaborative learning moves to online, the level of cognitive challenges for the activity increases (Capdeferro & Romero, 2012; Mayer, 2014; Roberts & McInnerney, 2007). This can be explained by the fact that social cues, including gestures, facial expressions, and tones, are more difficult to be transmitted and interpreted in online settings (Capdeferro & Romero, 2012; Korkmaz & Yesil, 2011; Roberts & McInnerney, 2007; Simon & Stauber, 2011). Moreover, a lack of social presence might result in an imbalance of the shared commitment (Capdeferro & Romero, 2012; Pisoni & Gijlers, 2021). The mentioned challenges might affect the effectiveness of collaborative learning and students' motivation negatively (Korkmaz & Yesil, 2011; Mayer, 2014). Meanwhile, there is limited research on online challenge-based learning, particularly research on how students' perceptions in online challenge-based learning change over time (Brodie, 2009; Gallagher & Savage, 2020; Leijon et al., 2021). This research is important to provide insights for teachers to better accommodate students' learning processes in online challenge-based learning.

Students' perceptions on groupwork

From the above-mentioned research, we learn that collaborative learning has a lot of potentials but is also a complex and difficult process. It is not surprising that students report mixed feelings about groupwork (Thompson, Anitsal, & Barrett, 2008). Students might not be keen on groupwork (Bosworth, 1994). Some doubt the effectiveness of groupwork (Li & Campbell, 2008). There are different factors influencing students' perceptions on groupwork. The first influencing factor is task value, which refers to students' perceptions of the interest, gains, and cost of the task (Eccles, 1983; Eccles & Wigfield, 2002). Only when students are confident that the potential benefits of groupwork outweigh their cognitive expense in hassles and frustrations, would students consider joining groups (Gerlach, 1994; Vauras, Volet, & Bobbitt-Nolen, 2019; Volet, 1997; Volet & Ang, 1996). Students would spend more time and effort in groupwork of electives and interests (Koh, 2020). Second, students' self-efficacy, referring to the confidence in their ability to contribute to groupwork without losing face, is another influencing factor (Volet, 2001). If students perceive the assignment to be challenging, students feel more positive about working in a group setting (Volet, 2001). Moreover, students' goals of collaboration and personal strategies to achieve those goals would shape perceptions on groupwork. Students have higher self-efficacy and motivation if they have extrinsic goals in problem-solving (Hendry, Ryan, & Harris, 2003; Othman & Idrus, 2019).

The cited literature demonstrates students' perceptions of groupwork are related to multiple aspects including management of the work, efficiency, and social aspects. A frequently used

instrument that addresses the multidimensional nature of students' perceptions on groupwork is the Student Appraisal of Group Assignments (SAGA) by Volet (2001). SAGA assesses theoretical constructs that are based on a review of educational, psychological, and cross-cultural research on groupwork (Volet, 2001, Volet & Ang, 1996). The SAGA instrument is used to assess students' appraisal of groupwork in the context of higher education; and it encompasses the theoretical background of various academic disciplines and research (e.g., Cotton, George, & Joyner, 2013). SAGA contains the following six constructs that provide insights into students' perceptions on groupwork. First, perception on the Cognitive Benefits refers to students' thinking about potential values, knowledge, skills that they would gain through groupwork rather than through learning individually (Volet, 2001). Second, perception on Motivation Influence refers to students' thinking about the team commitment and encouragement from team members (Volet, 2001). Third, perception on Affect means students' general feeling over solving the tasks in the group, if they find groupwork boring, if they feel confident about their skills and their contribution to the groupwork, if they trust their team members, and if they find team members having consistent behaviors (Volet, 2001). Fourth, perception on Interpersonal refers to students' thinking about the general group atmosphere, the possibility of getting along, and the group inclusivity (Volet, 2001). Fifth, perception on Management refers to students' thinking about the way the group reaches consensus, communicates, coordinates, and manages time (Volet, 2001). Sixth, perception on Group Assessment is students' thinking about having the same grades as other team members (Volet, 2001).

Students' perceptions on groupwork can be influenced by the behavior of other team members during the project (Capdeferro & Romero, 2012; Chang & Brickman, 2018; Pisoni & Gijlers, 2021). If a student feels that he is making valuable contributions, but his team members are taking it easy, this behaviour might influence the student's perceptions on groupwork negatively. And in the end, this situation might even result in negative group experiences and low group performance. Prior research emphasized the importance of early identification of collaboration patterns (Pisoni, Gijlers, Nguyen, & Chen, 2021) and students' perceptions over individual and group contributions during groupwork (Chang & Brickman, 2018; Pisoni & Gijlers, 2021). However, little is known about students' perceptions in the context of online challenge-based learning (Brandyberry & Bakke, 2006; Capdeferro & Romero, 2012; Gallagher & Savage, 2020; Koh & Hill, 2009; Leijon et al., 2021). It is not clear which constructs of students' perceptions could be signs of unsuccessful groups (Chang & Brickman, 2018; Leijon et al., 2021). This type of research is necessary to gain insights for teachers in supporting and facilitating students' collaborative processes in online challenge-based learning.

Current research

Based on the literature review, it is interesting to investigate students' perceptions on online challenge-based learning in relation to group performance. This would help to provide teachers the perceptions' change patterns and indicators of groups that need help in online challenge-based learning. Our research aims to study students' perceptions according to the multidimensional SAGA instrument (Volet, 2001) during challenge-based learning to answer the following questions:

1. To what extent do students' perceptions according to the SAGA instrument change in online challenge-based learning?
2. How do students' perceptions on online challenge-based learning change in relation to group performance?
 - 2a. Can one or more of the six constructs of students' perceptions measured by the SAGA instrument be used as indicators of less successful groups in online challenge-based learning?
 - 2b. If students' perceptions change, how can these changes be explained?

General Method

Our research consists of two experiments on groupwork in the context of challenge-based learning. We used the same research instruments in both experiments. The research was conducted in two existing challenge-based courses. However, the actual content of the task, the characteristics of the participants, and the timeline for both studies differed. Our data collection was adapted to align with the offered course context and timeline. Because of the different numbers of participants, the data analysis approach differed across experiments. In the general method section, we will start by introducing the instruments that were used in both experiments. Then, we will report the participants, procedures, data analysis, results, discussion of the first experiment, followed by the corresponding sections of the second experiment.

Instruments

Three questionnaires were to measure students' perceptions: initial questionnaire, midterm questionnaire, and endterm questionnaire. For each experiment, one focus group was conducted to better understand students' experiences in groupwork. All instruments focused on the six constructs of the SAGA instrument.

Questionnaires

Three questionnaires were based upon the SAGA Students' Appraisals of Group Assignments (SAGA) instrument by Volet (2001). The questionnaires assessed the following six constructs of students' perceptions: Cognitive Benefits, Motivation Influence, Affect, Interpersonal, Management,

and Group Assessment. All questionnaires were delivered online and featured a similar layout with seven sections. The first section was the participant's name and contact for pseudonym-coding purposes; the remaining sections contained items for six constructs of students' perceptions. Each question item offered a four-point Likert scale from "Totally disagree" (one point) to "Totally agree" (four points). However, there were small variations in the verb tenses of the items for each questionnaire depending on when the questionnaire was administered (before, during, and after groupwork). In the midterm questionnaires (two), we asked students to differentiate between their contribution and the contribution of their team members. The reliability scores of questionnaires in each experiment will be reported in the respective experiment section.

Initial questionnaire. The initial questionnaire aimed to measure students' expectations about groupwork before they started working on the online challenge-based assignment. To explain the details of the initial questionnaire, the Cognitive Benefits section, included three items; the scale for Motivation Influence included four items; the scale for Affect included four items; the Interpersonal scale included three items, the Management scale included two items; and the Group Assessment scale included two items. The detailed list of question items in the initial questionnaire can be found in Annex A.

Midterm questionnaire. The midterm questionnaire measured students' perceptions in two midterm points of groupwork. The midterm questionnaire assessed students' perceptions on their behaviors as well as their contributions and their team members' contributions to the groupwork. Students self-reported their contributions and reflected on the behaviour of the team and their team members. For each construct, items aimed at the individual as well as students' opinions about the group are selected. Some new items are added to offer an equivalent construct cover for perceptions about individual and group contributions. The scale aimed at Cognitive Benefits consisted of two individual items, contextualized from the Perceptions of Collaborative Learning Activities PCLA questionnaire by Mouw, Saab, Pat-El, and van den Broek (2019) and two new group items newly created on the reference of original individual items. This combination resulted in a scale of four items. The scale for Motivation Influence included two individual items and three group items, adapted from Carless & De Paola (2000) and Kormanski (1990); this resulted in a scale of five items. The Affect scale contained one individual item and three group ones, which were adapted from Jarvenpaa, Knoll, and Leidner (1998) and one newly created individual item; this resulted in a scale of five items. The scale of Interpersonal comprised of three individual items and one group one, adapted from Savicki, Kelly, and Lingenfelter (1996) and Saavedra, Early, and Van Dyne (1993); this resulted in a scale of four items. The Management scale consisted of three items from Mouw et al. (2019) and two new items, which resulted in a scale of five items. The scale of Group Assessment consisted of two individual items and

three group items, adapted from Deleau (2017) and George (1992), resulting in a scale of five items. The detailed list of question items in the midterm questionnaire can be found in Annex B.

Endterm questionnaire. The endterm questionnaire assessed students' perceptions after completion of the groupwork. The content of the questionnaire's six sections contained the same adapted and contextualized items from Volet's (2001) SAGA that we used to develop our initial questionnaire. To better understand the difficulties of groupwork and the strategies that students used to overcome the difficulties, 15 items from Hadwin, Bakhtiar, and Miller (2018) were added to the questionnaire. These additional items were categorized into the respective scales of SAGA available in the endterm questionnaire. Specifically, the scale of Cognitive Benefits included six items. The Motivation Influence scale included five items. The scale Affect included four items. The scale Interpersonal included seven items. The scale of Management included nine items. The scale of Group Assessment included two items. The detailed list of question items in the endterm questionnaire can be found in Annex C.

Group performance grading

Group performance was determined based on the group report. Coding criteria to assess the group performance were built by the principal researcher in collaboration with the course instructors, inspired by the assignment requirements. The three group performance levels are *low*, *average*, and *high*. The principal researcher was the main coder; the second coder was the course instructor. The detailed coding criteria in each experiment will be provided in the respective experiment.

Focus group

A focus group session was to collect qualitative data of students' perceptions over groupwork in each experiment. Students joining the qualitative design part were chosen with case sampling techniques, randomly from critical cases (e.g. high/ low/ average-performing groups). A question outline, based on Volet's (2001) six SAGA constructs, was developed to record students' perceptions about groupwork and to further investigate which aspect of groupwork (related to the six SAGA constructs) impacts students' perceptions. There were four items for Cognitive Benefits construct, two items for Motivation Influence construct, one item for Affect construct, four items for Interpersonal construct, three items for Management construct, and one item for Group Assessment construct. The questions were arranged in logical order to ensure the natural flow of conversations with students. The question list acted as a general outline for the focus group. In the actual focus group, some questions might be skipped if students had answers for them in their earlier responses to prior questions. The detailed list of questions in the focus group can be found in Annex D.

Experiment 1

Participants and design

Thirty-six students from various master programmes signed up to participate in the study. All students were enrolled in an elective Financial Technology course at the University of Trento (Italy). Four students dropped the course due to personal circumstances. Students were assigned to groups, resulting in nine groups: five groups of four students and four groups of three students. We ensured each group consisted of students with a technology background (for example computer science) and students with a business or behavioral science background to create cross-disciplinary balance.

Though 32 students took the questionnaires, three students did not complete all four questionnaires. Hence, the results of 29 students (12 female; 17 male) who answered questionnaires completely were included in the analysis. Students' ages were not included in the database due to privacy reasons. Five students were chosen to participate in a focus group with case-sampling techniques, one from a high-performing group, one from an average-performing group, and three from two low-performing groups.

The assignment

During the five-week elective Financial Technology course, student teams were required to design a framework of sustainable investments for clients of a financial organization. The desired investment framework would contain investment portfolios with a focus on Environmental, Social, and Governance (ESG), clean investments, and payments in the supply chain. The approach required students to think about end-to-end processes, data points, data providers, the product (green bonds, cleantech investments, regulatory design, etc.), the users, and the benefits to both the company and the customers. All student groups were required to write a final report and make an oral presentation.

Instruments and Procedure

Reliability test

The reliability test results of three questionnaires in Experiment 1 were as follow.

Initial questionnaire. The Cronbach alpha results were: .85 for the Cognitive Benefits scale, .75 for the Motivation Influence scale, .81 for the Affect scale, .21 for the Interpersonal scale, .40 for the Management scale, and .81 for the Group Assessment scale.

Midterm questionnaires. The Cronbach alpha results of the Cognitive Benefits scale were .57 at the first midterm, and .61 at the second midterm. For the Motivation Influence scale, Cronbach alpha was .70 at the first midterm and .91 at the second midterm. The Affect scale had a Cronbach of .68 at the first midterm, and .74 for the second midterm. The Interpersonal scale got the Cronbach of

.70 at the first midterm and .87 at the second midterm. The Management scale had a Cronbach of .67, and .62 at two midterm points respectively. The Group Assessment scale had a Cronbach of .61 at the first midterm and .76 at the second midterm.

Endterm questionnaire. The endterm questionnaire had a Cronbach of .85 for the Cognitive Benefits scale, .90 for the Motivation Influence scale, .84 for the Affect scale, .82 for the Interpersonal scale, .88 for the Management scale, and .80 for the Group Assessment scale.

Group performance grading

Group performance was determined based on the group report. Coding criteria to assess the group performance were built by the principal researcher in collaboration with the course instructors, inspired by the assignment requirements. The three group performance levels are *low*, *average*, and *high*.

Criteria to assess the quality of the group report included: (1) the data points about Environmental, Social, and Governance (ESG) are recommended and supported with academic and industry reference sources, (2) potential industries or companies are suggested with reasonable logic, and (3) framework of green portfolio investments with the name of investment products, respective weights, and evaluation scheme for the report. Two groups were categorized as high-performing groups, four groups were rated in average-performance level, and three groups were low-performing ones. A second coder coded 90% of the submissions, resulting in a Cohen's kappa of .94.

Among 29 participants in Experiment 1, seven students fell into low-performing groups, 13 students into average-performing groups, and nine students into high-performing groups.

Procedure

Course materials were delivered through the online learning system, Google Classroom. Due to the Covid-19 situation, all lectures were delivered online with Google Meet. In the first two weeks of the course, students received lectures; in the remaining three weeks they completed their group assignment. Students were assigned to groups during the first week of the course. During the challenge-based project, students were able to consult with the teacher and industry experts on their design idea and receive formative feedback on their group progress.

Three questionnaires were administered at four time points (before, midpoint 1, midpoint 2, and after completing the groupwork). Questionnaires were announced in the online learning system and through the lecturer. Each student received an individual invitation to complete the questionnaire through the UT Qualtrics platform. A focus group was also conducted to better understand students'

experience in groupwork. The focus group was completed two weeks after the submission of the final course assignment. The timeline of Experiment 1 is shown in Table 1.

Table 1

Timeline of Experiment 1 with the main content of sessions

Week	Class activities	Research timeline
1	<i>Session 1</i> <ul style="list-style-type: none"> • Lecture on Financial Technology and Entrepreneurship • Presentation of case study • Group arrangement 	Initial questionnaire
2	<i>Session 2</i> <ul style="list-style-type: none"> • Lecture on Financial Technology and Entrepreneurship • Groupwork session 	
3	<i>Session 3</i> <ul style="list-style-type: none"> • Groupwork session 	Midterm questionnaire (1)
4	<i>Session 4</i> <ul style="list-style-type: none"> • Groupwork session 	Midterm questionnaire (2)
5	<i>Session 5</i> <ul style="list-style-type: none"> • Final presentation • <i>Group report submission</i> 	Endterm questionnaire
6		Focus group arrangement
7		Focus group

Analysis

Initially, the mean score of each scale in four questionnaires was calculated. Student IDs were pseudonymized. To answer the research questions, we conducted the following statistical tests. Firstly, we compared students' perceptions before and after groupwork. Secondly, looking further in each performance level, we explored the differences in students' perceptions before, during, and after the groupwork. The ANOVA (analyses of variance) with repeated measures analysis was conducted to indicate if and how students' perceptions had changed in each group performing level. The tests were two-tailed with the alpha set at 0.05. Thirdly, students' perceptions about individual and group contributions were explored to explain their experiences.

Regarding qualitative data from the focus group, the exploratory qualitative data approach was conducted. Here, students' answers were coded by the positive comments and the negatives or "difficulties" comments. The comments were categorized into emergent themes and the six SAGA constructs. If a student made multiple similar statements about the same point, these were counted as one idea. Coded items of similar content were grouped into categories. These categories would indicate which aspect of groupwork (related to the SAGA six constructs) students used to describe their

experiences with the online challenge-based projects. These categories could also offer insights as to why students' perceptions changed over the duration of the online challenge-based projects.

Results

Students' perceptions before and after groupwork

Students' perceptions on six constructs were compared before and after groupwork with paired sample t-test. On average, perception scores on Cognitive Benefits before groupwork ($M = 3.24$, $SD = 0.39$) was higher than after groupwork ($M = 3.04$, $SD = .59$). The difference in perception scores on Cognitive Benefits, 0.20, 95% CI [-0.01, 0.41], was not statistically significant, $t(28) = 1.957$, $p = .06$, $d = 0.514$. Averagely, perception scores on Motivation Influence before groupwork ($M = 2.97$, $SD = 0.10$) was higher than after groupwork ($M = 2.88$, $SD = .14$). The difference in perception scores on Motivation Influence, 0.08, 95% CI [-0.25, 0.41], was not statistically significant, $t(28) = .514$, $p = .611$, $d = 0.135$. On average, perception scores on Affect before groupwork ($M = 2.91$, $SD = 0.62$) was lower than after groupwork ($M = 2.93$, $SD = .63$). The difference in perception scores on Affect, -0.026, 95% CI [-0.25, 0.19], was not statistically significant, $t(28) = -0.240$, $p = .812$, $d = 0.063$. On average, perception scores on Interpersonal before groupwork ($M = 2.91$, $SD = 0.43$) was lower than after groupwork ($M = 2.92$, $SD = .46$). The difference in perception scores on Interpersonal, -0.01, 95% CI [-0.19, 0.18], was not statistically significant, $t(28) = -0.089$, $p = .930$, $d = 0.023$. On average, students' perception scores on Management before groupwork ($M = 2.50$, $SD = 0.58$) was lower than after groupwork ($M = 3.13$, $SD = 0.52$). The difference in perception scores on Management, -0.63, 95% CI [-0.92, -0.34], was statistically significant, $t(28) = -4.512$, $p < .001$, $d = -1.18$. Also, students' perception scores on Group Assessment before groupwork ($M = 2.72$, $SD = 0.66$) was lower than after groupwork ($M = 3.14$, $SD = 0.80$). The perception difference, -0.41, 95% CI [-0.79, -0.40], was statistically significant, $t(28) = -2.27$, $p = .031$, $d = -0.596$. This means that students had the higher perception scores on Management and Group Assessment constructs after groupwork. For other four perception constructs, students did not have significant changes after groupwork.

Students' perceptions over the project duration in different group performance levels

Six one-way repeated measures analyses of variance (ANOVA) were conducted to assess differences of perceptions in each particular students' perception construct at four different time points (before, the first midterm, the second midterm, and after groupwork) in each performance level.

The one-way repeated measures ANOVA analysis revealed that, only students' perceptions in high-performing groups had significant perception changes for Motivation Influence construct ($F(3, 24) = 3.49$, $p = .03$, $\eta^2 = .194$), for Interpersonal construct ($F(3, 24) = 4.558$, $p = .012$, $\eta^2 = .191$) and for

Management construct ($F(3, 24) = 13.063, p < .001, \eta^2 = .422$). For other perception constructs of students in high-performing group, there were no significant differences found along the time, with Cognitive Benefits construct ($F(3, 24) = 1.088, p = .37, \eta^2 = .064$), Affect construct ($F(3, 24) = 2.16, p = .119, \eta^2 = 0.054$), and Group Assessment construct ($F(3, 24) = 2.463, p = .087, \eta^2 = .150$).

Plus, no significant differences were found along the time in the average-performing groups, with Cognitive Benefits ($F(3, 36) = .960, p = .422, \eta^2 = .037$), Motivation Influence ($F(3, 36) = .817, p = .493, \eta^2 = .035$), Affect ($F(3, 36) = .144, p = .933, \eta^2 = .008$), Interpersonal ($F(3, 36) = 1.055, p = .38, \eta^2 = .030$), Management ($F(3, 36) = 2.405, p = .083, \eta^2 = .099$), and Group Assessment ($F(3, 36) = .669, p = .557, \eta^2 = .037$). Similarly, no significant changes were found in low-performing groups, with Cognitive Benefits ($F(3, 18) = 2.522, p = .090, \eta^2 = .112$), Motivation Influence ($F(3, 18) = .966, p = .430, \eta^2 = .059$), Affect ($F(3, 18) = .148, p = .93, \eta^2 = .009$), Interpersonal ($F(3, 18) = 1.503, p = .248, \eta^2 = .090$), Management ($F(3, 18) = 2.024, p = .147, \eta^2 = .135$), and Group Assessment ($F(3, 18) = 1.096, p = .376, \eta^2 = .069$).

Generally, these results indicate that students in high-performing groups had a higher score of perceptions over time in the Motivation Influence, Interpersonal, and Management constructs. In other words, students in high-performing groups would likely report more positive scores about their perceptions on Motivation Influence, Interpersonal, and Management constructs. Meanwhile, students in average-performing and low-performing groups would not likely report significant changes in perception scores on the six SAGA constructs.

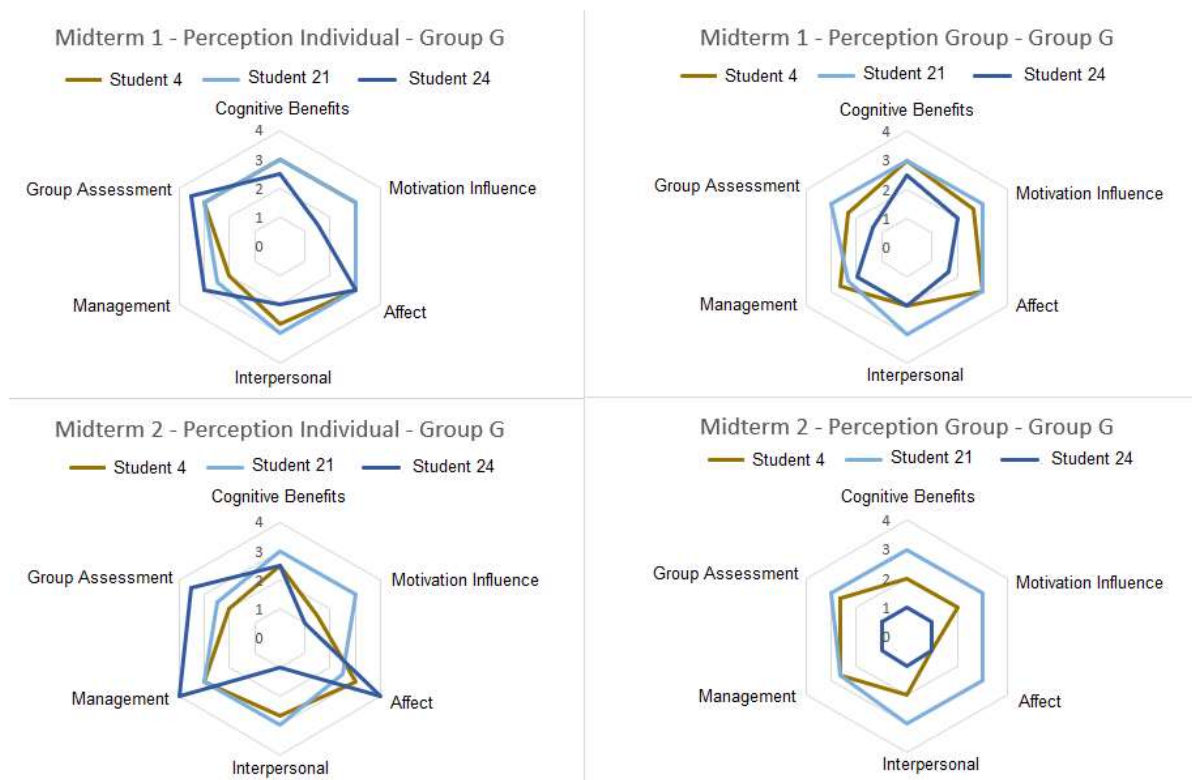
Perceptions on individual & group contribution at the middle points of the challenge-based project

To further explore students' perceptions in three group performance levels, we reviewed the students' perceptions on individual and group contribution in each construct at two middle points of the challenge-based project.

The results from two midterm questionnaires were visualized with radar charts with values of six perception constructs. For each midterm, members in the same team would have their perceptions on individual and group contributions calculated. These results were displayed on the same radar charts by the perceptions of individual or group ones. Each student has his/her line in the radar chart, connecting results of perception scores on the six constructs at six axes accordingly. These radar charts were related to the qualitative data obtained in the focus group to gain more insights into students' groupwork experience. Figure 1 is the radar charts of Group G. Group G was a prominent example of an average-performing group with free-riding issues. We selected Student 24 for commentary. We explored the radar charts of perceptions (especially for Student 24) together with focus group data to better understand students' perceptions changes during groupwork.

Figure 1

Radar charts of perceptions on individual and group contributions of Group G



Reviewing the radar charts of perceptions by individual and group contributions (Group G, *Figure 1*), we noticed that the perceptions on the individual contribution of three group members varied notably in Midterm 1, especially for perceptions on Motivation Influence and Interpersonal constructs. The variation in perceptions among team members means that the individual had little motivation influence and interpersonal connections with other team members. Student 24 had the perception on Motivation Influence lowest, less than the normal average of perceptions. Meanwhile, the perception on group contributions stayed smaller than the area of perceptions on individual contribution in Group G. The gap between individual and group contribution implied an initial sign of workload imbalance. The lack of motivation influence and interpersonal connections was also reflected in the sharing of Student 24 in the focus group.

I think (it) was a big problem...There was not that relationship, that base where you can build on, or you can have a really good work.... You have to be able to communicate and we weren't... Each of us did his work. And in the end, it was my work, his work.

I didn't ask [for help]. To be honest, even if I had, I probably wouldn't have gotten an answer...We work together, but it was, like, (the) bare minimum. We didn't bond; we didn't laugh that much.

Reviewing the second midterm, we noticed that the area of individual perceptions grew smaller than the respective part in the first midterm, with the lowest points for Motivation Influence and Interpersonal constructs, especially for Student 24. The decrease indicated an increasingly negative group experience for student members. The work distribution Group G was imbalanced.

Each of us did his thing. I then checked everything. But I don't have a positive experience. I didn't have a positive review before. So even if it is difficult... in the end, it was not recognized that much work that each of us put differently the work effort. So I took all work.

I mostly did the work by myself. So doing this, knowing that you might possibly find someone that doesn't really want to put their effort into the work, (it) was really time-consuming.

Overall, these results suggested that the drastic decreases in perceptions on Motivation Influence and Interpersonal constructs in the midterms would imply an imbalanced workload among members, negative group experience, and free-riding issues.

Difficulties of groupwork

Our qualitative data from the focus group was conducted in the exploratory approach to gain deeper insights into students' experiences. The findings were presented according to emergent themes from the data analysis, which focused mainly on the correlation and changes of students' perceptions in multiple time points in three different performance levels. The students' answers in the focus group revealed the explanation behind the respective changes and phenomena.

Generally, these results indicated that students in high-performing groups had a greater score of perceptions over time in the Motivation Influence, Interpersonal, and Management constructs. In other words, students in high-performing groups tend to report more positive perception scores on Motivation Influence, Interpersonal, and Management constructs. This was also illustrated in students' answers during the focus group. Some students in the high-performing group said that they decided to stay in the group, rather than dropping the course, because they enjoyed interacting with their team members, thus groupwork had a motivational influence on their course commitment.

I thought about dropping. The only reason I didn't is that I really had fun with my group in the meetings we had. So I was liking it, to decide not to drop. (Student 35)

For the Management construct, the high-performing group members were willing to support each other in doing the group project.

When we wanted to ask something because it wasn't clear, we were very happy to give others a hand. We were fine helping each other. (Student 18)

We asked for help just when we finished our work just to make sure it makes sense with what the other had done and to make sure we didn't repeat ourselves with the others, or we did contradict each other. (Student 35)

Additionally, the focus group data brought insights into why students in three different performance levels did not show significant changes in their Cognitive Benefits construct. The two most prominent reasons mentioned were time pressure and the approach used in allocating the group workload. Firstly, all students in the focus group emphasized the time limitation on the course. They did not clearly understand assignment requirements from the beginning. It took much time to understand the assignment requirements. Hence, most of the work was done at the later part of the course, leading to an imbalance in workload distribution throughout course duration.

We came to different conclusions. But that's not just because we're different people but also because the task wasn't really extremely well explained. (Student 35)

...as Student 35 said, it was a very broad topic. It was really difficult to find something to focus on, maybe the most precise task. It would be easier also... to find the direction in which the group had to move because the main difficulty was to understand what we were tasked for. Maybe the broad task made it more difficult for a group to understand and to decide on what problem. (Student 32)

Secondly, the strategy in group task division also limited the cognitive benefits of challenge-based learning. Most students in the focus group said their groups just divided the tasks based on each person's strength and combined their individual work into the group product mechanically.

We work together but it was more like, okay, so what we have to do (is) ABC. Student 18 will do A, a different friend will do B, and I will do C, ... It was more like working each by himself. But it's some coordination between individuals. (Student 32)

It was like puzzle combination ... we had to because, unfortunately, the work was not worth (it) at the end. (Student 18)

We didn't really check each other's work. Like we didn't read it, but we trusted each other. (Student 35)

For all groups in the focus group, students recognized that their team members became unwilling to spend more time and effort on the project.

The main goal of our strategy (was) just to minimize the time effort... We didn't focus on the work quality, because as a team, we found that it was the priority to finish as soon as possible (Student 32)

We didn't want to spend too much time on it, even though we had fun. (Student 35)

Discussion

Integrating the quantitative and qualitative findings, we found insights into how students' perceptions change in online challenge-based learning and why these changes can be explained. From quantitative results, students had higher perception scores on Management and Group Assessment constructs while having no changes in other perception constructs. This means students recognized the additional benefits of experiencing challenge-based learning, however, the gained cognitive benefits were little. This little gain of cognitive benefits was reflected in the way students combined their individual works mechanically, rather than collaborating properly. Two main reasons for this behaviour were mentioned in students' focus group comments. Firstly, one reason was the task value, particularly since the course in Experiment 1 was an elective. Students were unwilling to spend time and effort on the project. Students tend to focus on extrinsic goals more than intrinsic goals to increase their self-efficacy in problem-based learning courses (Othman & Idrus, 2019). For the elective course, with the limitation of extrinsic goals, students would likely not spend much effort in working diligently, leading to little cognitive benefits and fewer visible impacts, as expected from previous studies. Another reason was time pressure. Problem-solving is time-consuming because students need to undertake several attempts to complete a satisfactory project (Mahasneh & Alwan, 2018; Mitchell, Canavan, & Smith, 2010). Time pressure limited students' chances of exploring the challenge, building connections with team members, and have meaningful group interactions.

Besides, it is identified that students in high-performing groups would likely report more positive about their experience over Motivation Influence, Interpersonal, and Management constructs. This was explained in focus group comments where students in these high-performing groups with positive interpersonal experience, had fun together and showed a willingness to help each other, which increased their commitment to the project and helped their group to perform better. At the same time, further analysis in both qualitative and quantitative data indicated that dramatic decreases in Motivation Influence and Interpersonal constructs would imply an imbalanced workload among members, negative group experience, and free-riding issues.

Experiment 2

Participants and design

Experiment 2 involved 16 students in a master program in computer science. All participating students were enrolled in a compulsory course of Digital Innovation in Finance at the University of Côte d'Azur (France). One student dropped the course. Students were assigned to groups randomly, resulting in four groups: three groups of four students and one group of three students. Students in each group had the same academic background.

Akin to Experiment 1, only students who completed all questionnaires were chosen for data analysis. The results of nine students (four female; five male) were included in the analysis. Similar to Experiment 1, students' ages were not included in the research data. Four students participated in a focus group, one student from a high-performing group, one student from an average-performing group, and two students from a low-performing group.

The assignment

During the thirteen-week course of Digital Innovation in Finance, the student groups were required to create solutions for one of two proposed case studies addressing sustainable investments for the industrial client. The first case study, dealing with car payment and experience, required students to suggest a new experience based on connected-car platforms and to include recommended technologies such as Android, android automotive, apple car-pay, voice interaction, and biometrics. The second case study, dealing with sustainability, required students to plan an application that would enhance people's understanding of climate change in their daily life by providing information about consumption and offering conservation tips; suggested technologies could include web and mobile applications, artificial technologies, chatbot, blockchain, etc. All student groups had to write a report and make an oral presentation.

Instruments and Procedure

Reliability test

Initial questionnaire. The Cronbach alpha results were as follows: .87 for the Cognitive Benefits scale, .79 for the Motivation Influence scale, .84 for the Affect scale, .21 for the Interpersonal scale, .40 for the Management scale, and .82 for the Group Assessment scale.

Midterm questionnaires. The Cronbach alpha results of the Cognitive Benefits scale in Experiment 2 were .77 at the first midterm, and .81 at the second midterm. For the Motivation Influence scale, Cronbach alpha was .82 at the first midterm and .73 at the second midterm. The Affect scale had a Cronbach of .78 at the first midterm, and .81 for the second midterm. The Interpersonal scale got the Cronbach of .30 at the first midterm and .67 at the second midterm. The Management

scale had a Cronbach of .81, and .62 at two midterm points respectively. The Group Assessment scale had a Cronbach of .85 at the first midterm and .54 at the second midterm.

Endterm questionnaire. In Experiment 2, the endterm questionnaire had a Cronbach of .88 for the Cognitive Benefits scale, .75 for the Motivation Influence scale, .87 for the Affect scale, .78 for the Interpersonal scale, .72 for the Management scale, and .98 for the Group Assessment scale.

Group performance grading

Similar to Experiment 1, group performance was determined based on the group report, with three group performance levels of *low*, *average*, and *high*. Coding criteria to assess the group performance were also built by the principal researcher in collaboration with the course instructors, inspired by the assignment requirements.

Criteria to assess the quality of the group report included: (1) idea description, (2) comparison with available services, (3) entry barriers, (4) future usage scenario, (5) potential early adopters, and (6) development strategy, respective weights, and evaluation scheme for the report. Two groups were categorized as high-performing groups, one group was rated in average-performance level, and one group was rated as low-performing. A second coder coded 100% of the submissions resulting in a Cohen's kappa of 1. Among nine participants in Experiment 2, there were three students in low-performing groups, two students in average-performing groups, and four students in high-performing groups.

Procedure

Course materials were delivered through the online learning system, Moodle. All lectures were delivered online via Zoom. The course content was distributed in eight sessions. From session 4 (week 6), groupwork sessions were included. Students were assigned to groups on the second session (week 3). During the project, students were able to consult with the teacher and industry experts on their design idea and receive formative feedback on their group progress.

Similar to Experiment 1, participants were asked to complete questionnaires before, during and after the groupwork. Questionnaires were announced in the online learning system by the principal researcher and delivered through emails on the Qualtrics platform. Each student had a unique survey link. Hence, the section of participant's name and contact for pseudonym coding purposes was removed. A focus group was conducted two weeks after the submission deadline of the course. The timeline of Experiment 2 is shown in Table 2.

Table 2*Timeline of Experiment 2 with main content of sessions*

Week	Class activities	Research timeline
1	<i>Session 1</i> • Lecture on Disruption in Finance: Fintech ecosystem	
2	<no classes>	
3	<i>Session 2</i> • Presentation of case study • Group arrangement	Initial questionnaire
	<i>Session 3</i> • Lecture • Testimonial from the field presentation (UX banking)	
4	<no classes>	
5	<no classes>	
6	<i>Session 4</i> • Lecture • Groupwork session	Midterm questionnaire (1)
7	<no classes>	
8	<i>Session 5</i> • Lecture • Groupwork session	
9	<i>Session 6</i> • Lecture • Groupwork session	
	<i>Session 7</i> • Lecture • Groupwork session	Midterm questionnaire (2)
10	<i>Session 8</i> • Final presentations	
11	<i>Group report submission</i>	Endterm questionnaire
12		Focus group arrangement
13		Focus group

Analysis

Similar to Experiment 1, mean scores for each scale in four questionnaires were calculated. Because of Experiment 2's small number of participants (nine), descriptive statistics were used to explore the quantitative data and to discern students' perception changes related to the six SAGA constructs before, during, and after the groupwork in varying performance levels. Following that, students' perceptions over individual and group contribution in the critical case at two midterm points were explored. An exploratory qualitative approach was used (following the same procedures as Experiment 1) to better understand how students' perceptions changed over time.

Results

Students' perceptions before and after groupwork

Overall, there were no significant differences between students' perceptions on each reported construct before and after groupwork. Details on each construct are now presented. On average, perception scores on Cognitive Benefits did not have significant differences between before ($Mdn = 3.00$) and after groupwork ($Mdn = 2.83$), with Wilcoxon signed-rank test result of $T = 14.50$, $z = -0.09$, $p = 0.93$, $r = -0.029$. Secondly, on average, perception scores on Motivation Influence did not have significant differences between before ($Mdn = 3.00$) and after groupwork ($Mdn = 2.80$), with Wilcoxon signed-rank test result of $T = 17.50$, $z = -0.59$, $p = 0.55$, $r = -0.198$. Thirdly, on average, perception scores on Affect did not have significant differences between before ($Mdn = 3.00$) and after groupwork ($Mdn = 3.25$), with Wilcoxon signed-rank test result of $T = 21.00$, $z = -1.20$, $p = 0.23$, $r = -0.4$. Fourthly, on average, perception scores on Interpersonal did not have significant differences between before ($Mdn = 3.00$) and after groupwork ($Mdn = 2.85$), with Wilcoxon signed-rank test result of $T = 11.00$, $z = -0.98$, $p = 0.33$, $r = -0.327$. Fifthly, on average, perception scores on Management did not have significant differences between before ($Mdn = 2.50$) and after groupwork ($Mdn = 3.00$), with Wilcoxon signed-rank test result of $T = 25.50$, $z = -1.05$, $p = 0.29$, $r = -0.350$. Sixthly, on average, perception scores on Group Assessment did not have significant differences between before ($Mdn = 3.00$) and after groupwork ($Mdn = 3.00$), with Wilcoxon signed-rank test result of $T = 10.00$, $z = -0.71$, $p = 0.48$, $r = -0.256$.

Students' perceptions over the project duration in different group performance levels

To assess the students' perceptions over the project duration at four measurement time points, statistical analyses were applied to the three group-performance levels. Table 3 shows the means and standard deviations of students' perceptions on six constructs for different group-performance levels at time points.

Overall, students' perceptions on the six constructs scored quite positive in low-performing groups, slightly lower than average-performing ones, and lowest at high-performing groups. The norms of mean scores for the six SAGA perception constructs have been around 2.00 (Kimmel & Volet, 2010; Volet, 2001). Notably, students' perceptions in high-performing groups had improved scores on Cognitive Benefits, Motivation Influence, Affect, Interpersonal, and Management constructs, starting at the commencement of the groupwork until its conclusion. By comparison, students in average-performing groups showed improvement only in the Affect construct. Scores in the other constructs (for the average-performing groups) either stabilized (Management) or decreased (Cognitive Benefits, Motivation Influence, Interpersonal). For low-performing groups, among the five mentioned

constructs, the Management construct increased over time (from 3.17 before groupwork, to 3.27 in midterm 1, 3.40 in midterm 2, to 3.22 after groupwork). The other constructs (for low-performing groups) were stable (Cognitive Benefits, Affect) or decreased (Motivation Influence, Interpersonal). Lastly, the sixth perception construct, Group Assessment, increased in average-performing groups but stabilized in the other two group-performance levels.

Table 3

Means and Standard deviations of students' perceptions by group performance levels

	Before project		1 st middle point		2 nd middle point		After project	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>Overall</i>								
Cognitive Benefits	2.96	.82	3.11	.56	3.06	.41	3.00	.57
Motivation Influence	2.86	.74	3.16	.43	3.13	.48	2.78	.57
Affect	2.72	.72	3.16	.42	3.02	.47	2.89	.79
Interpersonal	3.00	.62	3.42	.35	3.36	.47	2.86	.40
Management	2.74	.62	3.00	.48	3.04	.46	2.90	.35
Group Assessment	2.94	1.04	3.04	.56	3.09	.45	3.06	1.13
<i>High-performing</i>								
Cognitive Benefits	2.50	.50	2.94	.36	2.75	.14	2.75	.31
Motivation Influence	2.44	.47	3.00	.16	3.10	.13	2.60	.41
Affect	2.25	.40	3.05	.13	3.00	.08	2.44	.49
Interpersonal	2.58	.28	3.44	.19	3.31	.31	2.75	.27
Management	2.50	.20	2.80	.22	2.95	.22	2.86	.12
Group Assessment	2.37	.62	2.85	.10	3.50	.13	2.37	.69
<i>Average-performing</i>								
Cognitive Benefits	3.17	.50	3.12	.12	3.12	.12	2.83	.00
Motivation Influence	2.87	.12	2.90	.10	2.70	.30	2.70	.10
Affect	2.75	.25	2.80	.00	2.50	.10	3.12	.12
Interpersonal	3.00	.00	3.37	.12	3.25	.25	2.79	.07
Management	2.50	.50	3.00	.40	2.70	.30	2.50	.06
Group Assessment	3.50	.50	2.70	.10	2.60	.00	4.00	.00
<i>Low-performing</i>								
Cognitive Benefits	3.44	.22	3.33	.33	3.42	.22	3.44	.31
Motivation Influence	3.42	.08	3.53	.29	3.47	.35	3.07	.18
Affect	3.33	.17	3.53	.29	3.40	.35	3.33	.30
Interpersonal	3.56	.29	3.42	.30	3.50	.25	3.15	.19
Management	3.17	.44	3.27	.24	3.40	.20	3.22	.17
Group Assessment	3.33	.44	3.53	.47	3.47	.29	3.33	.33

Note. The maximum score is 4

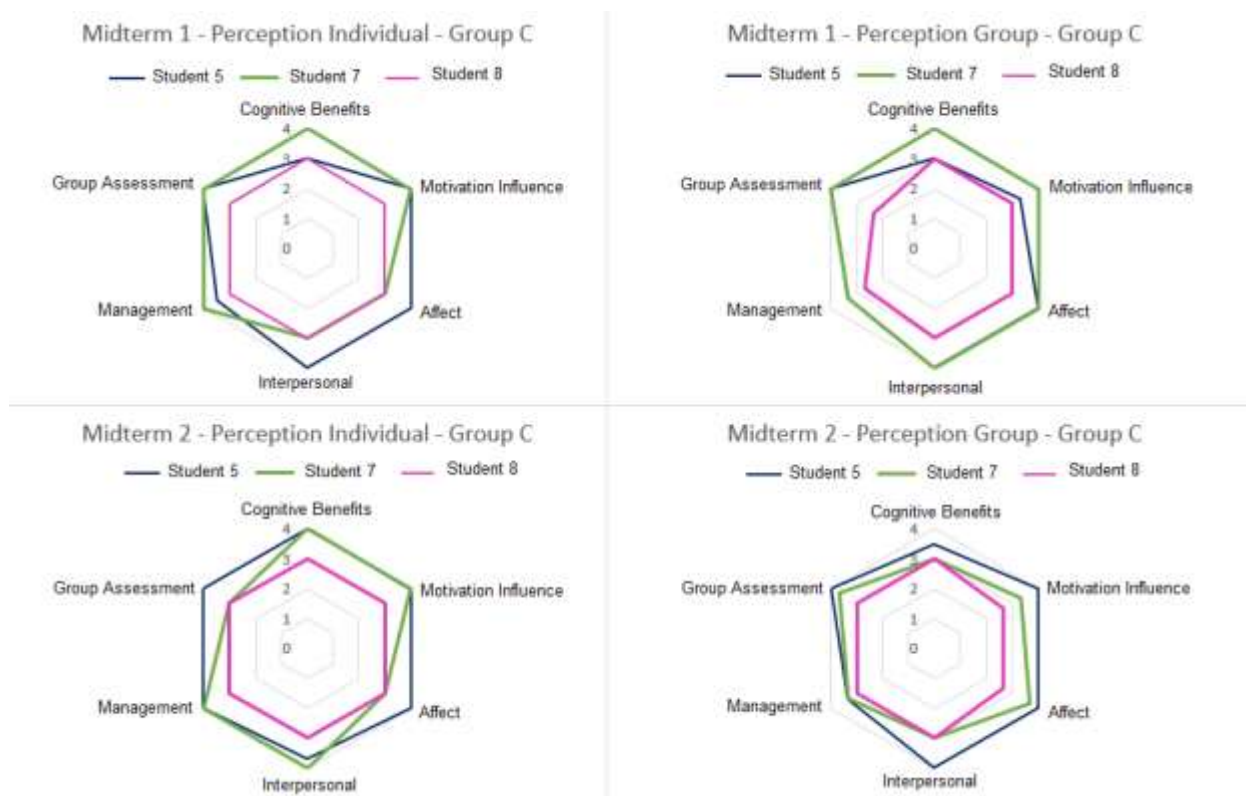
Generally, in Experiment 2, these results indicate that students reporting decreasing perception scores on Motivation Influence and Interpersonal constructs would likely not be in high-performing groups.

Perceptions on individual & group contribution at the middle points of the challenge-based project

We investigated perceptions on individual and group contributions at two middle points of the challenge-based project, applying a similar approach as the one used in Experiment 1. Figure 2 is the radar charts of Group C. It was a low-performing group having two students participating in the focus group. This group was selected because of identified free-riding issues in the group. Group members (Student 7 and Student 8) participated in the focus group. The radar charts of perception scores were combined with information from the focus group for mean-making. We focused on the radar charts of Student 7 and Student 8 who joined the focus group to better understand the perception changes and experiences.

Figure 2

Radar chats of perceptions on individual and group contributions of Group C



Closer inspection in the radar charts in *Figure 2*, students in Group C overall reported positive perception scores related to the six SAGA constructs. However, how perception scores changed over the duration of the assignment varied. Specifically, there was little change in Student 8's perceptions in both individual and group contributions at two midterm points. Meanwhile, Student 7 had the perception scores in Interpersonal increase and Group Assessment decrease (individual perceptions), and Cognitive Benefits, Motivation Influence, Interpersonal decrease (group perceptions) in the later midterm. The perception decreases imply that Student 7 and Student 8 experienced either a negative

change or no improvements in their experience. This phenomenon was also reflected in Student 8's comments during the focus group. The workload distribution was uneven but team members seemed to accept the free-riding willingly.

[help others] I don't mind helping others at all. I think it is normal. That's also part of teamwork. Taking the groupwork as the whole, not seeing it as individual work. (Student 8)

For our group, it was (a kind of) specific issue at the end of the project. One of our team members got overloaded with (his) job. We all three divided his part. So I wouldn't say it was often. It was really (just) once but everybody was okay with this. It was you're just taking responsibility for one part for three other team members, not so much extra job. For me, it was okay when it was not often. (Student 7)

In short, the stalling or decreasing perception scores on Motivation Influence and Interpersonal in the midterms radar charts would likely indicate the imbalance workload among members.

Difficulties of groupwork

Regarding the difficulties of groupwork, focus group answers were analysed with the same approach used in Experiment 1. We noticed the impacts of longer course duration in students' group experience in Experiment 2. Students from all groups found the workload of the challenge-based project manageable. Students felt no time pressure to complete the challenge-based assignment without having proper feedback from team members.

The workload is very well distributed. (Student 7)

We had the end of the course so close to the deadline (that) we accidentally missed some points so we could not fulfill those points. Some had to take care of them. Some could not make it because they had jobs or something like that. It was one team member (who) had to fix all those parts. It was the only moment of time pressure for us. Otherwise, in general, it was not much. Only the final touch was a bit pressured. (Student 14)

Additional time likely helped them better facilitate the group and have more time in providing feedback and reach group decisions. Conflicting ideas in a team were solved mostly based on group discussions.

Sometimes you really see that other members of the team (are) really eager for ideas. And he's like: "Oh, wow, guys, let's do like this. Let's do that because I think it will be super perfect."

And you're not arguing because you see the fire in his eyes and say, yeah, maybe, these guys really know something, and I will listen to him, I will change my part. (Student 7)

For me, when I have feedback from my colleagues, normally I consider it because it's always constructive. Or maybe if they give you feedback that you are not agreeing with because you have a different opinion... So you can discuss and you can maybe get to a middle point, you know, I think like the feedback is always good. You can take it if it's constructive, or you can maybe not taking into consideration if it's not like you think completely different, but it's always good to hear it. (Student 8)

In most cases, I redo according to the feedback. So, yeah, but it is usually a small part of the feedback. Or sometimes even my classmates do it for me. When it's obvious that there is some kind of mistake when it was there... Actually, in the worst case, a compromise, in the best case, agreement. (Student 14)

Moreover, group interactions also helped them to gain more cognitive benefits over the course content and with friends' contributions.

We had a French citizen, I could learn about the French issues, which I wouldn't be able to find. Also, we had a Spanish classmate in the team, I could know how it happens in Spain. And because our business idea was in the whole of Europe, so I could get this perspective (of) how it actually works now. (Student 14)

You'll really see how to improve your presentation skill because you're here with other people. You'll improve your speech, improve your storytelling. And I think when you work alone, it's not that easy to prepare a presentation like that. (Student 7)

Students were willing to offer and receive help from other members.

[asking for help] Of course, I asked for help from my colleagues when I was traveling, or when I knew they had more knowledge of the subject. (Student 8)

Some of the group members have a lot of stuff to do. You can take more of the work so they can take more in the end. (Student 7)

Group interactions also enabled students to have heightened expectations over their assignment marks.

In the beginning, I didn't know how well my colleagues can write or do the research. The first results which we did, like a shallow idea brainstorming, (was) not that good. So I thought maybe it gonna be challenging. One part is done very badly by this person. But then surprisingly, I was very lucky with colleagues. They did surprisingly great. So I think my grade expectation was growing. (Student 14)

Because the students came from the same program, they knew each other already. The prior acquaintance enhanced their inter-group experiences. Students received help not only within their same group but also from other groups.

We came here in September. We had team-building activities, and of course, we knew each other. (Student 7)

In the master, we all were helping each other a lot. We are not a huge group. So I think it was super good to help. And not only in this class but in other subject classes as well. They always were there to help each other before. When I have a problem. I spell it out. I could just say "Hey, can you help me?". Of course, I could ask the professor, but normally they were less helpful, or they are more occupied, or maybe they don't even know. So it was like, I don't know, I know a friend who was super helpful with helping me with how to install things. So that's what we'll like. (Student 8)

For me, it's common (like) to ask for feedback because my level of English is worse than the rest of the people have. The master then normally always has for a bit of help like writing or correcting the paragraphs when we have time, obviously... For me, (what) is really helpful (is) when somebody helped me a bit with.. solving some problems on the English. And then it's true that there are not related with the language is more related with the topic. (Student 9)

However, students still confronted external difficulties during groupwork. One difficulty was the influence of the industry experts. They found the advice from industry experts conflicted with each other. Also, students were expecting a more focused introduction from the company expert rather than an overview of company products, as the students experienced. An ideal introduction from industry experts would be more of a storytelling-based introduction, telling stories about the market needs and problems, and how ideas were initiated, developed, and implemented.

We had two experts. And at one point during the project, we changed like mentoring. So we were initially mentored by one person, (then) mentored by another person. They were pointing at super different stuff and we didn't expect changes from the second mentor as we

would predict. I see feedback from them really other advice, really other requirements. And we were really not prepared (for) this. (Student 7)

I would appreciate more personal stories from mentors because, like we said, we try to learn here and we don't really know how to do stuff. So we improvised and then we had feedback. The mentor is supposed to know it better. So probably, in the beginning, it would be nice to have more thoughts with mentors about their own business. We had guys who were CEO of companies, so they already did stuff that worked. So why don't they share this with us? Why don't we see real examples of their job? It was rather than we just try to implement something in our projects that are not real. (Student 14)

Another feedback point from students concerned the course objectives. They found the course focused on the stage of exploration and conceptualization of the design phase, similar to other courses which they had already taken in the program. Students had hoped the program curriculum could enable the challenge-based course to cover more advanced topics or contain higher thinking levels (e.g. making prototypes, real products, start-up).

Our business task [challenge] was repeating itself. Many times we did the same (in different courses). We do ideas, we figure out ideas, we do presentations, we do report and here it ends. And in real life or startup, there are a lot of other things which are related to the startup and I'm a bit upset that we didn't, we always do the same and we never try some skills which are more relevant for a startup. (Student 14)

We had a lot of subjects about the same, more or less, like doing different projects... But we did all the time the same. And when it was different (topic), it didn't have a path, you know, or something that you could follow, (like) the guidelines to do something. It was simply like, okay, yeah, I show you my presentation. And they tell you okay, but you should have done this, you should have done that. So it was never clear. (Student 8)

Taken together, these results provided insights explaining why students' perceptions changed in the six SAGA constructs. The student comments also highlighted the influence of task value on time and effort which students put in the groupwork. In the compulsory course with more time, students felt less pressure and could have more meaningful group interactions, which enabled feedback and enhanced cognitive benefits. Also, when students were acquainted with each other before doing groupwork, the students' inter-group experiences improved. However, there were still difficulties arising, such as conflicting advice from industry experts and the connection of the challenge-based course with the program curriculum.

Discussion

Combining both quantitative and qualitative results, we had an overview of students' perceptions on online challenge-based learning. Students in Experiment 2 did not have significant differences between perception scores before and after groupwork in the six SAGA constructs. This result may be due to the small number of participants (nine), which were too few to reflect the prominent trends statistically in perception changes before and after groupwork. Nevertheless, in the focus group, students claimed to develop skills and additional knowledge after working in online challenge-based projects.

Regarding students' perceptions in varied performance levels, students who showed stagnant or decreasing perception scores on Motivation and Interpersonal constructs would likely not be in the high-performing groups. This result is similar to the one in Experiment 1.

Experiment 2 results highlighted the influence of task value on students' time and effort in groupwork. In the compulsory project course with more time as Experiment 2, students felt less pressured and could engage in more meaningful group interactions. Besides the course duration, Experiment 2 was different in students' prior acquaintances and topic choices. With prior acquaintances, students had more advantages in enhancing their group interactions and inter-group experiences. This could facilitate a higher level of trust (Tseng & Yeh, 2013) and better group performance (Siebert, Mills, & Tuff, 2009; Lou & MacGregor, 2004). Plus, offered topic choices would positively affect students' motivation and task performance (Ryan & Deci, 2006). Despite these advantages in Experiment 2, students experienced difficulties in challenge-based projects, including conflicting advice from industry experts and the connection of the course project with the program curriculum.

General Discussion

Challenge-based learning offers students chances to work together on real-life problems and gain additional knowledge and skills from learning experiences (Malmqvist et al., 2015). However, it is challenging to support and engage students in meaningful learning experiences to maximize the potentials of challenge-based learning (Chang & Brickman, 2018; Phunaploy et al., 2021; Suryanti & Supeni, 2019). The challenges increase even more in online settings and mixed students' feelings over groupwork (Chang & Brickman, 2018; Roberts & McInerney, 2007; Simon & Stauber, 2011). This research aimed to explore how students' perceptions change in online challenge-based courses in relation to group performance levels, according to Volet's (2001) SAGA instrument. Difficulties hindering students to gain benefits from challenge-based learning were also investigated to explain the perception changes. This general discussion section compares findings across the two experiments,

thus, allowing for explanations and justifications of the findings in accordance with the previous research.

The first research question on to what extent students' perceptions generally change according to the SAGA instrument in online challenge-based learning? sought to determine the differences in students' perceptions on six constructs before and after groupwork. The differences in perception scores before and after groupwork in Experiment 1 were significant in Management and Group Assessment, with the perception scores on these two constructs after groupwork being higher than the respective scores before groupwork. No significant differences in students' perceptions before and after groupwork were found in Cognitive Benefits, Motivation Influence, Affect, and Interpersonal constructs. Meanwhile, Experiment 2 does not have significant differences between perception scores before and after groupwork in the six SAGA constructs, though students claimed to get additional knowledge and skills in the focus group. These inconsistent results between Experiment 1 and Experiment 2 might derive from different course duration, the possibility of choosing topics, and the small number of participants in Experiment 2. With more time in Experiment 2, students had chances to collaborate meaningfully and gained more knowledge and skills from collaboration activities. Plus, the possibility of choosing topics enabled students' motivation and performance (Ryan & Deci, 2006). Students were more engaged in collaboration and consequently gained more cognitive benefits. However, the small number of participants (nine) in Experiment 2 were too few to reflect the prominent trends in perception changes before and after groupwork for the six constructs.

Previous research indicated that challenge-based learning would bring students cognitive benefits (Edelson, Gordin, & Pea, 1999; Freeman et al., 2004; Singer, Tal, & Wu, 2003), motivation to study (Frank, Lavy, & Elata, 2003; Green, 1998), students' self-learning skills, and improved relations among students (Requies, Agirre, Barrio, & Graells, 2018). However, our findings over students' perceptions do not reflect all these positive impacts of challenge-based learning. This is because previous works were conducted in experimental settings which compared challenge-based learning cases with traditional method cases, while our research had the challenge-based learning cases only. Nevertheless, our findings suggest that students recognized several benefits of challenge-based learning. Especially in Experiment 2, students collaborated, developed skills, had more meaningful learning experiences, and gained knowledge and skills. Our findings confirm the earlier observations about students' perceptions of utility value in challenge-based learning by Beier, Kim, Saterbak, Leautaud, Bishnoi, and Gilberto, 2019. Further research needs to be done in online challenge-based learning in more control settings to provide definitive evidence.

The second research question was how students' perceptions changed during the project in different group performance levels. In Experiment 1, we found that students in high-performing groups

tend to report more positive perception scores related to Motivation Influence, Interpersonal, and Management constructs. Experiment 2 showed that students who report stagnant or decreasing perception scores on Motivation Influence and Interpersonal constructs would likely not be in high-performing groups. These two findings seem to be in line. This finding on perception changes might stem from the situation that students who did not experience challenge-based learning properly seldom reach the high-performing levels. Usually, in challenge-based learning, students can formulate their own learning requirements, become autonomous, and engage in problem-solving (Bilbao et al., 2018). Such attributes provide a sense of connection between the task and peers (Almulla, 2020). Hence, students who did not engage in solving the task problems would not connect holistically with the tasks and their peers. Consequently, these students not in high-performing groups might exhibit stagnant or decreasing perception scores on Motivation Influence and Interpersonal constructs .

With this mentioned result, we extend the current literature theoretically on online challenge-based learning about how students' perceptions change during groupwork. We also made a first attempt in identifying factors that influence students' perceptions. While most prior studies have concentrated on the general impacts of challenge-based learning (Beier et al., 2019; Edelson et al., 1999; Freeman et al., 2004; Frank et al., 2003; Green, 1998; Hall et al., 2012; Reques et al., 2018; Suryanti & Supeni, 2019; Singer et al., 2003; Wolff, 2003; Zhang et al., 2009), our research investigated students' perceptions in challenge-based learning in relation to group performance levels. Our findings also broadly support the work of the study in identifying struggling teams through signs at the early stages of groupwork (Pisoni, Gijlers, Nguyen, & Chen, 2021). It would be possible to identify struggling teams within the very first stage of groupwork. In our research, the sign could be identified in the midterm perception radar charts.

As indicated earlier, we found that students recognized the potential of challenge-based learning. We also learn that difficulties exist and hinder students to make the most of the collaborative learning experiences. Through our identified difficulties, namely time, task value, inconsistent assignment advice from industry experts, and the connection of challenge-based projects with the program curriculum, our findings also raise intriguing questions over the suitable workload for group assignments given the course duration and course characteristics. Particularly, challenge-based learning requires students to take charge of organizing and monitoring their groupwork (Bilbao et al., 2018). Problem-solving is time-consuming (Mahasneh et al., 2018; Mitchell et al., 2010). Students have to spend time on organizing their groupwork and solving the problem. Plus, in online settings, it would take a longer time for students to notice issues that negatively affect the group performance (Simon & Stauber, 2011). Consequently, applying challenge-based learning in online time-compressed courses would risk causing cognitive overload. Challenge-based learning would be less appropriate for time-

compressed courses. Further research should be carried out to establish deeper understandings of the cognitive load of online challenge-based courses. To minimize difficulties in groupwork, teachers can devise strategies to promote students' learning experience, by providing targeted interventions to facilitate the learning. These interventions could include: 1) providing students with an overview of the important tasks and milestones for the group assignment to help students optimize management of their groupwork (Dao, 2020), 2) orienting industry experts on how to efficiently interact with students (Ibwe et al., 2018), and 3) raising students' awareness of how the challenge-based course aligns with the general program (Roberts & McInerney, 2007).

The study has two limitations. The first limitation concerns the weak reliability rates of Interpersonal and Management scales in initial questionnaires and some constructs in the midterm questionnaires. The overview of Cronbach alpha results in both experiments is in Annex E. The reliability limitation could be due to two reasons. First, the number of items in each construct of midterm questionnaires was small while covering students' perceptions on both individual and group contributions. However, we decided not to remove any midterm questionnaire items to increase the Cronbach alpha reliability results because removing items would danger the content validity of the midterm questionnaires. A possible second explanation for these low reliability rates might be students interpreted the concepts behind the questionnaires differently. All questionnaires were self-reported. In future research, students should know about the concepts before answering the questionnaires. Though having the reliability limitation, the study used focus groups to collect more qualitative data to add further insights into student experiences. The second limitation is that the results in Experiment 2 only partly replicated the results of Experiment 1. Some discrepancies between the findings of the two experiments could be explained by advantages of choice, similar background, and additional time for students in Experiment 2. Despite the inconsistent result limitation, findings in Experiment 2 certainly helped verify the initial findings of students' perceptions from Experiment 1.

Overall, our findings extend the understanding of students' perceptions of online challenge-based learning in relation to performance levels, groupwork difficulties, and suggest a guide for teachers to identify struggling teams and to better design and facilitate challenge-based courses.

Conclusion

Our research is an important step to understanding more students' perceptions in online challenge-based learning. From our result findings, teachers could identify student groups that need helps by observing students' perception scores on Motivation Influence and Interpersonal constructs, according to Volet's (2001) SAGA instrument. The students reporting stagnant or dramatically decreasing scores in Motivation Influence and Interpersonal would likely not be in high-performing groups. Students recognized that they could learn valuable skills from experiencing challenge-based learning but the difficulties exist, namely, time pressure, task value, industry assignment advice, and the connection between the challenge-based assignment and the program. Challenge-based learning would be less appropriate for time-compressed courses. To minimize difficulties to students during groupwork, teachers would consider if the course and timeline are appropriate for challenge-based projects, provide guidance to industry experts on how to best interact with students, and emphasize to students how the challenge-based assignment contributes to the program outcomes.

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Annex

Annex A – Initial Questionnaire

* Likert scale: Strongly disagree (1) to Strongly agree (4)

1. Cognitive Benefits

- 1.1. Interacting with peers for this group assignment will enrich my knowledge and understanding of Fintech
- 1.2. Working in a group will provide me with the opportunity to get feedback on my understanding.
- 1.3. This group assignment will give me a chance to learn from my peers contribution and different opinions.

2. Motivation Influence

- 2.1. It is highly motivating for me to work on this assignment with a group of peers.
- 2.2. I'm likely to stay throughout this assignment because it is completed as a group.
- 2.3. In this assignment we will motivate each other.
- 2.4. My motivation for this course decreased because this assignment will be done in groups

3. Affect

- 3.1. I love the idea that this assignment is going to be a group project.
- 3.2. I am happy to work on this assignment with a group of peers.
- 3.3. I am angry that this assignment has to be completed as a group.
- 3.4. Working on such an assignment with a group of peers will be quite exciting.

4. Interpersonal

- 4.1. I think this type of group assignment will generate conflict among members.
- 4.2. This group assignment provides the opportunity for everyone to feel included.
- 4.3. In this assignment it will be easy to create a group atmosphere where everyone feels comfortable to express their views.

5. Management

- 5.1. I expect it will be hard to reach consensus when working on this group assignment.
- 5.3. Finding an effective way of coordinating the work between the group members will be quite difficult.

6. Group Assessment

- 6.2. We should not have be assessed as a group for this assignment.
- 6.3. I would prefer it if this assignment would have been assessed on an individual basis.

Annex B – Midterm Questionnaire

1. Cognitive Benefits

Individual

- 1.1. By working in a group on the assignment, I have been learning more than I would have learned individually
- 1.2. I am putting forward my ideas and arguments.

Group

- 1.3. I think team members are learning more than they have done on their own.
- 1.4. I think team members are putting forward their ideas and arguments.

2. Motivation Influence*Individual*

- 2.1. I'm unhappy with my team's level of commitment to the task.
- 2.2. Team members are not giving me enough opportunities to improve my personal performance

Group

- 2.3. Team members are being united together in trying to achieve the project goals.
- 2.4. Team members have conflicting aspirations for the team's performance.
- 2.5. Team members are encouraging and appreciating comments about group efforts.

3. Affect*Individual*

- 3.1. I try to behave in a consistent manner to set the expectation from other members.
- 3.2. I feel very confident about my own skills and my own contribution in this team assignment.

Group

- 3.3. Team members are trying hard to be fair in dealing with one another.
- 3.4. Team members have a strong sense of commitment.
- 3.5. Team members are well qualified.

4. Interpersonal*Individual*

- 4.1. I am not feeling that people listened to me when I had an idea about the problem.
- 4.2. I am feeling that I could express my thoughts and feelings openly to others on the network while solving the problem.
- 4.3. Given the way group members are performing their roles, I often feel frustrated.

Group

- 4.5. Most people in our group are getting along with one another.

5. Management*Individual*

- 5.1. Because we have to work in a group, I am finding it difficult to understand what we need to do.
- 5.2. I am being afraid to ask my group members for help.

Group

- 5.4. We are quickly agreeing on what to write for the project.
- 5.5. Everybody is feeling safe and free to ask for help from other members.
- 5.6. We are struggling to arrange time for our online meetings.

6. Group Assessment*Individual*

- 6.2. How I am performing my task is important for our assignment.
- 6.3. Group assignment's success is my focus.

Group

- 6.4. Our current task division is fair among members.
- 6.5. Some team members are not being proactive in taking additional tasks and having initiatives in groupwork
- 6.6. Team members are taking it easy and letting others do the work.

Original subscales*Cognitive Benefits**

- PCLA questionnaire (Mouw, Saab, Pat-El, & van den Broek, 2019)

(1 = strongly disagree, strongly agree = 4)

1. We all listened to each other.
2. All group members participated actively. For example everyone helped to decide on what to write.
3. We quickly agreed on what to write for the project.
4. I enjoyed working on the assignment with our group.
5. Because we had to work in a group, I found it difficult to understand what we needed to do.

6. By working in a group on the assignment, I have been learning more than I would have learned individually.

7. I think I have answered most of the questions correctly.

8. I am putting forward my ideas and arguments.

9. During group work, we made eye contact.
10. We did not Interrupt each other and let each other finish our sentences.
11. I learned a lot from this assignments.
12. We gave each other compliments on a regular base.
13. We have considered ideas from all group members.
14. We first discussed how we would approach this task.
15. I was afraid to ask my group members for help.
16. I am satisfied with our project.
17. I made an effort to understand what my group members meant.

Motivation influence

- Task Cohesion (Carless & De Paola, 2000)

1. Team members were united together in trying to achieve the project goals
2. Team members were happy with the team's level of commitment to the task
- 3. I'm unhappy with my team's level of commitment to the task (R)**
- 4. Team members have conflicting aspirations for the team's performance (R)**
- 5. Team members do not give me enough opportunities to improve my personal performance (R)**

- Team Development Scale (Kormanski, 1990)

1. Commitment--Group members understand group goals and are committed to them/ Team members were happy with the team's level of commitment to the task
2. Acceptance--Group members are friendly, concerned, and interested in each other.
3. Clarification--Group members acknowledge and confront conflict openly.
4. Belonging--Group members listen with understanding to others.
5. Involvement--Group members include others in the decision-making process.
6. Support--Group members recognize and respect individual differences.
7. Achievement--Group members contribute ideas and solutions to problems.
8. Pride--Group members value the contributions and ideas of others.
9. Recognition--Group members recognize and reward group performance.

10. Satisfaction--Team members are encouraging and appreciating comments about group efforts

Affect

- Antecedents of trust (Jarvanpaa et al. 1998)

Integrity

1. Team members try hard to be fair in dealing with one another

2. Team members have a strong sense of commitment

3. I never am doubtful about whether other team members will do what they promised

4. I like the work values of the members on this team

5. Team members do not behave in a consistent manner – I am never sure if they are going to do what they promise or not

6. The other team members display a solid work ethics

Trust

1. If I had my way, I wouldn't let the other team members have any influence over issues that are important to the project

2. I would be comfortable giving the other team members complete responsibility for the completion of this project

3. I really wish I had a good way to oversee the work of the other team members on the project.

4. I would be comfortable giving the other team members a task or problem that was critical to the project, even if I could not monitor them.

Ability

1. I feel very confident about my own skills and my own contribution in this team assignment.

2. The other team members have much knowledge about the work that needs to be done

3. The other team members have specialized capabilities that can increase our performance

4. Team members are well qualified

5. The other team members are very capable of performing their tasks

6. The other team members seem to be successful in the activities they undertake.

Interpersonal

- Group-process Satisfaction Scale (Savicki, Kelly & Lingenfelter, 1996)

1. I enjoyed talking with my group on the network.

2. I felt good that I could participate with my group in coming to a conclusion about the problem.

3. I am not feeling that people listened to me when I had an idea about the problem. (R)

4. I am feeling that I could express my thoughts and feelings openly to others on the network while solving the problem.

5. I did not feel that people understood my thoughts and feelings after I expressed them while solving this problem. (R)

6. I felt like my group worked very hard together to solve this problem.

- Intra-group conflict scale (Saavedra, Early, & Van Dyne, 1993)

1. There was a lot of tension among people in our group

2. Team members never interfered with each other's work - group

3. Most people in our group are getting along with one another - group

4. Given the way group members performed their roles I often felt frustrated - individual

5. I found myself unhappy and in conflict with members of my group

6. People I dependent on to get my job done in the group often let me down

7. I found myself in conflict with other group members because of their actions (or lack of actions)

Management

- PCLA questionnaire by Mouw, Saab, Pat-El, & van den Broek (2019)

1. We all listened to each other

2. All group members participated actively. For example everyone helped to decide on what to write

3. We are quickly agreeing on what to write for the project

4. I enjoyed working on the assignment with our group

5. Because we had to work in a group, I found it difficult to understand what we needed to do

6. By working in a group on the assignment, I have learned more than I would have learned individually

7. I think I have answered most of the questions correctly

8. I have put forward my ideas and arguments

9. During group work, we made eye contact

10. We did not interrupt each other and let each other finish our sentences

11. I learned a lot from this assignments

12. We gave each other compliments on a regular base

13. We have considered ideas from all group members

14. We first discussed how we would approach this task

15. I was afraid to ask my group members for help

16. I am satisfied with our project

17. I am making an effort to understand what my group members meant

Group assessment

- Social loafing construct validity by (Deleau, 2017) which are adapted from George (1992)

1. The loafer deferred responsibilities s/he should have assumed to others.

2. The loafer put forth less effort when others were around to do the work.

3. The social loafer did not do his or her fair share of the work. -> Our current task division is fair among members

4. The loafer spent less time helping members if others were present to do it.

5. The social loafer put forth less effort than other members of the team.

6. The social loafer avoided performing housekeeping tasks as much as possible.

7. The loafer left work that s/he should have completed others to complete.

8. The loafer did not exercise initiative if others were available to do the task. -> Some team members aren't being proactive in taking additional tasks, initiatives in groupwork

9. The social loafer took it easy and let other team members do the work. - Team members are taking it easy and letting others do the work.

10. The loafer deferred project-related tasks to other team members

- Origins of perceived social loafing (George, 1992)

Task visibility

1. My teacher is generally aware of when a group member is putting forth below average effort

2. My teacher is aware of the amount of task I do

3. It is generally hard for my teacher to figure out how hard I am working (R)
4. My teacher usually notices when a group member is slacking off
5. It is difficult for my teacher to determine how hard we are working (R)
6. It is hard for my teacher to determine how much effort I exert on the assignment (R)

Contribution

- 1. I think that I am making a unique contribution to how successful our assignment is**
- 2. How I am performing my task is important for our assignment**
- 3. Group assignment's success is my focus**

Social loafing

1. Defers responsibilities he/she should assume to other members
2. Puts forth less effort on the assignment when other members are around to do the work
3. Does not do his/her share of the work
4. Spends less time working on the assignments if other members are present working on the assignment together
5. Put forth less effort than other members of his/her group work
6. Avoid performing housekeeping tasks as much as possible
7. Leave work for the next members which he/she should really complete

Annex C – Endterm Questionnaire

1. Cognitive Benefits

- 1.1. Interacting with peers for this group assignment enriched my knowledge and understanding of Fintech.
- 1.2. Working in a group provided me with the opportunity to get feedback on my understanding.
- 1.3. This group assignment gave me a chance to learn from my peers contribution and different opinions.
- 1.4. We had different understandings of the course materials.
- 1.5. We made use of good strategies to get the task done.
- 1.6. We developed confidence and assertiveness from the groupwork.

2. Motivation Influence

- 2.1. It highly motivated me to work on this assignment with a group of peers.
- 2.2. I stayed throughout this assignment because it is completed as a group.
- 2.3. In this assignment we motivated each other.
- 2.4. My motivation for this course decreased because this assignment was done in groups
- 2.5. We had different levels of commitment to the task.

3. Affect

- 3.1. I loved the idea that this assignment is a group project.
- 3.2. I am happy to work on this assignment with a group of peers.
- 3.3. I am angry that this assignment had to be completed as a group.
- 3.4. Working on such an assignment with a group of peers was quite exciting.

4. Interpersonal

- 4.1. I think this type of group assignment generated conflict among members.
- 4.2. This group assignment provided the opportunity for everyone to feel included.

4.3. In this assignment it was easy to create a group atmosphere where everyone feels comfortable to express their views.

4.4. We had different working styles.

4.5. We had troubles understanding each other.

4.6. We had different styles of interacting (e.g. quiet, bossy, confrontational)

4.7. We got difficulties communicating due to language barriers.

5. Management

5.1. It was hard to reach consensus when working on this group assignment.

5.3. Finding an effective way of coordinating the work between the group members was quite difficult.

5.4. We got trouble staying on task.

5.5. We had different goals/ standards for our work.

5.6. We developed a good plan of attack.

5.7. We had trouble using the technology.

5.8. We ran out of time.

5.9. We monitored our task progress as we went.

5.10. We made changes to our approach when we recognized things weren't going well.

6. Group Assessment

6.2. We should not have be assessed as a group for this assignment.

6.3. I would prefer it if this assignment would have been assessed on an individual basis.

Original subscales

- Challenges & Strategies of groupwork (Hadwin et al., 2008)
- 1. Challenge1: We had different understandings of the course materials (Do)
- 2. Strategy2: We made use of good strategies to get the task done (Do)
- 3. Strategy13: We developed confidence and assertiveness from the groupwork (Groupwork)
- 4. Challenge2: We had different levels of commitment to the task (Do)
- 5. Challenge3: Unmotivated group members (Groupwork)
- 6. Strategy1: Got motivated (Do)
- 7. Strategy3: We maintained focus on the task (Do)
- 8. Challenge6: We had different ideas about how to start (Plan)
- 9. Challenge7: Different strategies or approaches (Do)
- 10. Challenge8: We had different working styles (Do)
- 11. Challenge9: We had troubles understanding each other (Do)
- 12. Challenge10: Unsupportive group climate (e.g. uncomfortable, unfriendly, lack of trust) (Groupwork)
- 13. Challenge11: We had different styles of interacting (e.g. quiet, bossy, confrontational) (Groupwork)
- 14. Challenge12: We got difficulties communicating due to language barriers (Groupwork)
- 15. Strategy4: Made sure we understood what we are supposed to do and why (Strategy – Plan)
- 16. Strategy5: Set specific goals about what we wanted to learn (Plan)
- 17. Strategy7: Managed the environment (Do)
- 18. Strategy8: Ask for help (Do)
- 19. Strategy9: Developed a positive group climate (Groupwork)

20. Strategy10: Used good communication skills (e.g. listening to each other, contributing ideas)
21. Challenge4: We got trouble staying on task (Do)
22. Challenge5: We had different goals/ standards for our work (Plan)
23. Strategy6: We developed a good plan of attack (Plan)
24. Challenge13: Different ideas about how to organize our time (Planning)
25. Challenge14: Different ideas about how to work together (Planning)
26. Challenge15: Different understandings of what we need to do (Planing)
27. Challenge16: We had trouble using the technology (Doing)
28. Challenge17: We ran out of time (Doing)
29. Challenge18: Different ideas about how to check progress (Check progress)
30. Challenge19: Different ideas about what to do when we run into problems (Check progress)
31. Challenge20: Different ideas about when to check progress (Check progress)
32. Strategy11: We monitored our task progress as we went
33. Strategy12: We made changes to our approach when we recognized things weren't going well
34. Strategy15: Did nothing, just moved on (Groupwork)
35. Challenge21: We have unequal participation or distribution of work (Groupwork)
36. Strategy14: We assigned specific roles to group members (Groupwork)

Annex D

Focus Group question list

1. Cognitive benefit & 4. Interpersonal (partly)

1.1. Could you share what you have learned from this online groupwork project? This could be any knowledge and skills which you think it would be more challenging for you to learn by yourself

1.2. Are there any personal goals, particular knowledge, skills which you wished to get from this group project but you could not learn yet?

4.1. Have you ever asked for help from other members? If yes, when was it?

1.3. Could you share me examples when you receive helpful or less helpful advices or feedback from other members? Why did you think the advice is not helpful? After receiving the feedback from other members, how did you fix your part in the project work?

4.2. How often did you have to support other members to complete their assigned parts?

1.4. How did you provide feedback to other members? Do you find group members address your feedback in improving project work?

2. Motivation influence

2.1. Did you set any grade expectations for this group assignment? If yes, what was it? Did you know the grade expectation of other members in the group?

2.2. Did your grade expectation change over the course time? If yes, what do you think is the reason for grade expectation changes?

5. Management & 6. Group assessment

5.1. What communication channel did you use? Did it fulfill your needs? Otherwise, why? How did you arrange meetings online as a group?

5.2. When did you assign roles? When you need to divide tasks, how did you assign roles or tasks? Do your group members ever have different ideas over the groupwork requirements or task divisions?

5.3. Did it take long time to reach an agreement in your group? What strategy did you use? Is it helpful? Could you tell us example of the situation when your group could successfully resolve the situation? Why? How about when the situation is unsuccessfully resolved? Why it is the case?

6.1. Do you think this group assessment is fair? Why or why not? Is group assessment unfair generally or only applied to this assignment only?

3. Affect

3.1. Did this group work experience motivate you to join future group work? In case less motivating, which experience from this groupwork demotivated you?

4. Interpersonal (Optional – possibly answered in 5.3 & 3.1)

4.3. When did you find most pleasant during this groupwork? Could you give us some examples of pleasant experience/ memories in groupwork?

4.4. How about the least pleasant moments? What is your group strategy to resolve these situations?

Annex E

Table 4

Cronbach alpha results of each construct scale in questionnaires

Cronbach alpha	Initial questionnaire	Midterm questionnaire 1	Midterm questionnaire 2	End questionnaire
<i>Experiment 1</i>				
1. Cognitive Benefits	0.85	0.57	0.61	0.85
2. Motivation Influence	0.75	0.70	0.91	0.90
3. Affect	0.81	0.68	0.73	0.84
4. Interpersonal	0.21	0.70	0.87	0.82
5. Management	0.40	0.67	0.62	0.88
6. Group Assessment	0.81	0.61	0.76	0.84
<i>Experiment 2</i>				
1. Cognitive Benefits	0.87	0.77	0.81	0.88
2. Motivation Influence	0.79	0.82	0.73	0.75
3. Affect	0.84	0.78	0.81	0.87
4. Interpersonal	0.83	0.30	0.67	0.78
5. Management	0.40	0.81	0.62	0.72
6. Group Assessment	0.82	0.85	0.54	0.98

Note. Cronbach alpha over .7 appears in bold.