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Identifying struggling teams in online challenge-based learning

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Abstract

Purpose – The purpose of the study is to determine how students perceive groupwork and identify patterns of less successful groups in online challenge-based learning.
Design/methodology/approach – This study involved 29 university students working in nine teams in an online challenge-based course. The authors 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.
Findings – Findings suggest that students reporting decreasing or stalling perception scores on the Motivation Influence, Interpersonal constructs would likely not be in high-performing groups. Additionally, challenge-based learning is less suitable for time-compressed courses.
Originality/value – The study expands the understanding of students' perceptions of online challenge-based learning, at different performance levels, and difficulties in these projects. Practical implications of this study are support 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
Paper type Research paper

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 professional careers, more bachelor and master programs include collaborative learning as an instructional strategy to equip students with the groupwork experience (Nam and Zellner, 2011). Collaborative learning is, for example, implemented in challenge-based learning courses in which students work on real-life problems in teams to practice work-related skills (Malmqvist *et al.*, 2015).

In challenge-based learning, students can learn from the dynamic and reciprocal interaction among people, environment, and behavior (Bandura, 1989; Phunaploy *et al.*, 2021; Suryanti and Supeni, 2019; Requies *et al.*, 2018). Because challenge-based learning addresses

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real-life problems, students could consult industry experts in devising solutions for the problems (Malmqvist *et al.*, 2015). Students can receive valuable feedback on their work from these experts to find the most relevant solution for the problem (Ibwe *et al.*, 2018). By working collaboratively, students evolve to become independent learners, critical thinkers, problem solvers, and team players (Lehtinen, 2003; Malmqvist *et al.*, 2015).

Although collaborative learning is a promising instructional approach, students report mixed feelings about groupwork (Thompson *et al.*, 2008; Bosworth, 1994). Some students doubt its effectiveness (Li and Campbell, 2008). Various factors influence students' perceptions on groupwork. The first factor is task value, which refers to students' perceptions of the interest, gains, and cost of the task (Eccles, 1983; Eccles and 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 (Vauras *et al.*, 2019; Volet, 1997). The second influencing factor is students' self-efficacy, referring to confidence in their ability to contribute to groupwork (Volet, 2001). If students perceive the assignment challenging enough, students feel more positive about groupwork (Volet, 2001). Students' goals of collaboration and their personal strategies also shape perceptions on groupwork. Students have higher self-efficacy and motivation if they have extrinsic goals in problem-solving (Hendry *et al.*, 2003; Othman and Idrus, 2019).

Students' perceptions on groupwork can also be influenced by the behavior of other team members (Chang and Brickman, 2018; Pisoni and Gijlers, 2020). If a student feels that they are making valuable contributions but their team members are not, the student's perceptions of groupwork might be negatively inclined, possibly resulting in negative group experiences and low group performance. When collaborative learning moves to online, the level of cognitive challenges increases (Mayer, 2014). This is because social cues are more difficult to be transmitted and interpreted online (Korkmaz and Yesil, 2011; Simon and Stauber, 2011). Lacking social presence might result in an imbalance commitment (Pisoni and Gijlers, 2020). The mentioned challenges might also affect the effectiveness of collaborative learning and students' motivation (Korkmaz and Yesil, 2011; Mayer, 2014).

The literature links students' perceptions of groupwork to multiple factors, including group management, efficiency, and social dynamics. A frequently used instrument addressing the multidimensional nature of students' perceptions on groupwork is the Student Appraisal of Group Assignment (SAGA) by Volet (2001). SAGA assesses theoretical constructs that are based on a review of educational, psychological, and cross-cultural research on groupwork in higher education (Cotton *et al.*, 2013; Volet, 2001). SAGA contains six constructs of students' perceptions on groupwork. First is perception on the Cognitive Benefits, referring to students' thinking about potential values, knowledge, and skills they would gain through groupwork rather than through individual learning (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 about solving the tasks in the group, such as if they find groupwork boring, if they feel confident about their skills and their contribution, and if they trust their team members (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).

Prior research emphasized the importance of early identification of collaboration patterns (Pisoni *et al.*, 2021) and students' perceptions over individual and group contributions during groupwork (Chang and Brickman, 2018; Pisoni and Gijlers, 2020). However, little is known

about students' perceptions in the online challenge-based learning (Gallagher and Savage, 2020; Koh and Hill, 2009; Leijon *et al.*, 2021), or how students' perceptions change (Gallagher and Savage, 2020; Leijon *et al.*, 2021). It is not clear which constructs of students' perceptions could signal unsuccessful groups (Chang and Brickman, 2018; Leijon *et al.*, 2021). Research in these areas is needed to help teachers better facilitate students' collaborative processes in online challenge-based learning. The more that is known about students' perceptions in relation to various group performance levels, the better teachers can identify potentially less successful groups and intervene to support them.

This study

Our research investigates students' perceptions in relation to group performance levels. We use the multidimensional SAGA instrument (Volet, 2001) to track students' perceptions during online challenge-based learning. Our research questions are as follows:

(1) To what extent do students' perceptions change in online challenge-based learning?

(2) How do students' perceptions of online challenge-based learning change in relation to group performance?

- Can one or more of the six SAGA constructs of students' perceptions be used as indicators of less successful groups in online challenge-based learning?
- If students' perceptions change, how can these changes be explained?

Method

This study was approved by the University of Twente ethical committee. The researcher visited the first online lecture of the course and informed the students about the study and invited them to participate. The information was also provided through an email to the participating students. Students could provide their consent through filling out an online consent form that inquired if students fully understood the nature of the study, and subsequently asked them for their consent. Only data from students who provided full consent was stored and used for research purposes.

Participants and design

Thirty-two students from various master programs participated in the study. Students' ages were not included in the database due to privacy reasons. All students were enrolled in an elective Financial Technology course. Students were assigned to nine groups: five groups of four students and four groups of three students. We ensured each group comprised students with a technology background and students with a social science background to create cross-disciplinary balance.

Of this cohort, 29 students (12 female; 17 male) completed all study questionnaires, whose results were included in the analysis. 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 course, student teams were required to design a framework of sustainable investments for a financial organization, write a final report, and make a presentation. The desired investment framework should 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, the users, and the benefits to the company and users.

Instruments

An initial questionnaire, midterm questionnaire, and endterm questionnaire were administered to measure students' perceptions. One focus group was conducted. All instruments focused on the six constructs of the SAGA instrument.

Questionnaires. Based upon Volet's (2001) SAGA instrument, the questionnaires measured six constructs of students' perceptions: Cognitive Benefits, Motivation Influence, Affect, Interpersonal, Management, and Group Assessment. All questionnaires were delivered online. All featured a similar layout, with the first section for the participant's name and contact for pseudonym-coding; and remaining sections for constructs of students' perceptions. Each question item featured a four-point Likert scale from "Totally disagree" (one point) to "Totally agree" (four points). Verb tenses of each questionnaire items varied, depending on when the questionnaire was administered (before, during, and after groupwork). Cronbach alpha results of questionnaires are displayed in Table 1 (Nunnally, 1978; Cronbach, 1951).

Initial questionnaire. The initial questionnaire measured students' expectations about groupwork before they started the assignment. The questionnaire comprised: the Cognitive Benefits section (three items); the Motivation Influence section (four items); the Affect section (four items); the Interpersonal section (three items); the Management section (two items); and the Group Assessment section (two items). The questionnaire is presented in Annex A.

Midterm questionnaire. The midterm questionnaire measured students' perceptions at two midterm points of groupwork. This questionnaire assessed students' perceptions on their individual behaviors as well as their contributions and their team members' contributions to the groupwork. For each construct, items focusing on 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. Our new items are either newly written or adapted from literature (Mouw *et al.*, 2019; Carless and De Paola, 2000; Kormanski, 1990; Jarvenpaa *et al.*, 1998; Savicki *et al.*, 1996; Saavedra *et al.*, 1993; Deleau, 2017; George, 1992). The midterm questionnaire with respective sources is presented in Annex B.

The midterm questionnaire comprised: the Cognitive Benefits section (four items); the Motivation Influence section (five items); the Affect section (five items); the Interpersonal section (four items); the Management section (five items); and the Group Assessment section (five items).

Endterm questionnaire. The endterm questionnaire assessed students' perceptions after completing the groupwork. The questionnaire contained the same items from Volet's

Cronbach alpha	Initial questionnaire	Midterm questionnaire 1	Midterm questionnaire 2	End questionnaire
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*

Note(s): Cronbach alpha over 0.7 appears in italic

Table 1.
Cronbach alpha results of each construct scale in questionnaires

(2001) SAGA instrument that were applied in the initial questionnaire. We also added 15 items from Hadwin *et al.* (2018) to the endterm questionnaire to understand the groupwork difficulties and the strategies that students used to overcome these difficulties. These additional items were categorized into the respective SAGA scales in the questionnaire.

The endterm questionnaire comprised: the Cognitive Benefits scale (six items); the Motivation Influence scale (five items); the Affect scale (four items); the Interpersonal scale (seven items); the Management scale (nine items); and the Group Assessment scale (two items).

The endterm questionnaire is presented 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.

Criteria to assess the quality of the group report included: (1) the data points about ESG are recommended and supported with sources; (2) potential industries or companies are suggested with reasons; and (3) the framework of green portfolio investments is proposed with the name of investment products and respective weights. Based upon these criteria, 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 0.94 (Cohen, 1960).

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

Focus group. Students joining the focus group 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 and to investigate which aspect of groupwork (related to the six SAGA constructs) impacts students' perceptions. The question list presented in Annex D acted as a general outline for the focus group.

Procedure

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

Conducting the research in an existing challenge-based course, we adapted our data collection to fit the course context and timeline. During five weeks of the course, three questionnaires were administered at four time points (before, midpoint 1, midpoint 2, and after completing the groupwork). The initial questionnaire was in week 1; midterm questionnaires were in week 3 and week 4; and the endterm questionnaire was in week 5. Questionnaires were announced in the online learning system and through the lecturer. Each student received an individual invitation to complete the questionnaire through the Qualtrics platform. The focus group was conducted two weeks after the final submission.

Data analysis

The mean score of each scale in four questionnaires was calculated. As we included only students completing all questionnaires in the analysis, we had no missing values in the dataset. Furthermore, for the scales we were working with, each scale includes multiple items

to measure a distinctive SAGA construct for a particular moment of the course (e.g. pre, midterm 1, midterm 2, or end-term) with reliability. Therefore, we could calculate the mean score for each scale through the means computation formula of SPSS. 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. We initially reviewed the descriptive statistics of each variable to confirm the normality distribution to conduct the analyses of variance (ANOVA) with repeated measures. Once we confirmed the normal distribution, the ANOVA with repeated measures were 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 the focus group data, the exploratory qualitative data approach was conducted. Students' answers were coded by positive comments, negative ones, 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, which would indicate the aspect of groupwork experience (related to the SAGA six constructs), in online challenge-based projects. These categories could also offer insights as to why students' perceptions changed during the project.

Results

Students' perceptions before and after groupwork

Students' perceptions on six SAGA constructs were compared before and after groupwork with paired sample *t*-test. Table 2 shows the results of analyses of students' perception scores before and after groupwork. On average, perception scores on Cognitive Benefits before groupwork ($M = 3.24$, $SD = 0.39$) was higher than after groupwork ($M = 3.04$, $SD = 0.59$). The difference in perception scores on Cognitive Benefits, 0.20, 95% CI [−0.01, 0.41], was not statistically significant, $t(28) = 1.957$, $p = 0.06$, $d = 0.363$. Averagely, perception scores on Motivation Influence before groupwork ($M = 2.97$, $SD = 0.56$) was higher than after groupwork ($M = 2.88$, $SD = 0.76$). The difference in perception scores on Motivation Influence, 0.08, 95% CI [−0.25, 0.41], was not statistically significant, $t(28) = 0.514$, $p = 0.611$, $d = 0.095$. On average, perception scores on Affect before groupwork ($M = 2.91$, $SD = 0.62$) was lower than after groupwork ($M = 2.93$, $SD = 0.63$). The difference in perception scores on Affect, −0.026, 95% CI [−0.25, 0.19], was not statistically significant, $t(28) = -0.240$,

Table 2.
Analyses of students' perception scores before and after groupwork

Perception score	Before *M*	Before *SD*	After *M*	After *SD*	B	95% CI *LL*	95% CI *UL*	t(28)	*p*	Cohen'd
1. Cognitive Benefits	3.24	0.39	3.04	0.59	0.20	−0.01	0.41	1.957	0.06	0.363
2. Motivation Influence	2.97	0.56	2.88	0.76	0.08	−0.25	0.41	0.514	0.611	0.095
3. Affect	2.91	0.62	2.93	0.63	−0.026	−0.25	0.19	−0.240	0.812	−0.045
4. Interpersonal	2.91	0.43	2.92	0.46	−0.01	−0.19	0.18	−0.089	0.930	−0.017
5. Management	2.50	0.58	3.13	0.52	−0.63	−0.92	−0.34	−4.512	*<0.001*	−0.838
6. Group Assessment	2.72	0.66	3.14	0.80	−0.41	−0.79	−0.40	−2.268	*0.031*	−0.421

Note(s): *p* less than 0.05 appears in italic

$p = 0.812$, $d = -0.045$. On average, perception scores on Interpersonal before groupwork ($M = 2.91$, $SD = 0.43$) was lower than after groupwork ($M = 2.92$, $SD = 0.46$). The difference in perception scores on Interpersonal, −0.01, 95% CI [−0.19, 0.18], was not statistically significant, $t(28) = -0.089$, $p = 0.930$, $d = -0.017$. 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, $t(28) = -4.512$, $p < 0.001$, $d = -0.838$. 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, $t(28) = -2.27$, $p = 0.031$, $d = -0.421$.

This means that students had the higher perception scores on Management and Group Assessment constructs after groupwork. For the 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 student's perception construct at four different time points (before, the first midterm, the second midterm, and after groupwork) in each performance level. The detailed results are presented in Table 3.

According to the ANOVA analysis, students' perceptions in high-performing groups had significant perception changes for Motivation Influence construct ($F(3, 24) = 3.49$, $p = 0.031$, $\eta^2 = 0.304$), for Interpersonal construct ($F(1.664, 13.310) = 4.558$, $p = 0.036$, $\eta^2 = 0.363$) with Mauchly's test of violated sphericity (χ^2 (5) = 13.147, $p = 0.023$) and Greenhouse-Geisser corrected test result ($\varepsilon = 0.555$), and for Management construct ($F(1.480, 11.842) = 13.063$, $p = 0.002$, $\eta^2 = 0.620$) with Mauchly's test of violated sphericity (χ^2 (5) = 12.014, $p = 0.036$) and Greenhouse-Geisser corrected test result ($\varepsilon = 0.493$). For other perception constructs of students in high-performing group, there were no significant differences found along the time, with Cognitive Benefits construct ($F(3, 24) = 1.088$, $p = 0.37$, $\eta^2 = 0.120$), Affect construct ($F(3, 24) = 2.16$, $p = 0.119$, $\eta^2 = 0.212$), and Group Assessment construct ($F(1.567, 12.538) = 2.463$, $p = 0.133$, $\eta^2 = 0.235$) with Mauchly's test of violated sphericity (χ^2 (5) = 11.692, $p = 0.041$) and Greenhouse Geisser corrected test result ($\varepsilon = 0.522$).

For average-performing groups, no significant differences were found along the time, with Cognitive Benefits ($F(3, 36) = 0.960$, $p = 0.422$, $\eta^2 = 0.074$), Motivation Influence ($F(1.750, 20.995) = 0.817$, $p = 0.440$, $\eta^2 = 0.064$) with Mauchly's test of violated sphericity (χ^2 (5) = 11.629, $p = 0.041$) and Greenhouse-Geisser corrected test result ($\varepsilon = 0.583$), Affect ($F(3, 36) = 0.144$, $p = 0.933$, $\eta^2 = 0.012$), Interpersonal ($F(1.679, 20.149) = 1.055$, $p = 0.355$, $\eta^2 = 0.081$) with Mauchly's test of violated sphericity (χ^2 (5) = 12.584, $p = 0.028$) and Greenhouse-Geisser corrected test result ($\varepsilon = 0.560$), Management ($F(3, 36) = 2.405$, $p = 0.083$, $\eta^2 = 0.167$) and Group Assessment ($F(1.605, 19.263) = 0.669$, $p = 0.492$, $\eta^2 = 0.053$) with Mauchly's test of violated sphericity (χ^2 (5) = 14.842, $p = 0.011$) and Greenhouse-Geisser corrected test result ($\varepsilon = 0.535$).

Similarly, no significant changes were found in low-performing groups, with Cognitive Benefits ($F(3, 18) = 2.522$, $p = 0.090$, $\eta^2 = 0.296$), Motivation Influence ($F(3, 18) = 0.966$, $p = 0.430$, $\eta^2 = 0.139$), Affect ($F(3, 18) = 0.148$, $p = 0.93$, $\eta^2 = 0.024$), Interpersonal ($F(3, 18) = 1.503$, $p = 0.248$, $\eta^2 = 0.200$), Management ($F(3, 18) = 2.024$, $p = 0.147$, $\eta^2 = 0.252$) and Group Assessment ($F(3, 18) = 1.096$, $p = 0.376$, $\eta^2 = 0.154$).

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.

Perception	Mauchly's test of sphericity P	χ^2 (5)*	Greenhouse-Geisser ε*	F F Range	F Ratio	p	η^2
High-performing							
1. Cognitive Benefits	0.147			(3, 24)	1.088	0.370	0.120
2. Motivation Influence	0.284			(3, 24)	3.49	*0.030*	0.304
3. Affect	0.251			(3, 24)	2.16	0.119	0.212
4. Interpersonal	*0.023*	13.147	0.555	(1.664, 13.310)	4.558	*0.036*	0.363
5. Management	*0.036*	12.014	0.493	(1.480, 11.842)	13.063	*0.002*	0.620
6. Group Assessment	*0.041*	11.692	0.522	(1.567, 12.538)	2.463	0.133	0.235
Average-performing							
1. Cognitive Benefits	0.336			(3, 36)	0.960	0.422	0.074
2. Motivation Influence	*0.041*	11.629	0.583	(1.750, 20.995)	0.817	0.440	0.064
3. Affect	0.677			(3, 36)	0.144	0.933	0.012
4. Interpersonal	*0.028*	12.584	0.560	(1.679, 20.149)	1.055	0.355	0.081
5. Management	0.390			(3, 36)	2.405	0.083	0.167
6. Group Assessment	*0.011*	14.842	0.535	(1.605, 19.263)	0.669	0.492	0.053
Low-performing							
1. Cognitive Benefits	0.521			(3, 18)	2.522	0.090	0.296
2. Motivation Influence	0.275			(3, 18)	0.966	0.430	0.139
3. Affect	0.233			(3,18)	0.148	0.930	0.024
4. Interpersonal	0.063			(3, 18)	1.503	0.248	0.200
5. Management	0.723			(3, 18)	2.024	0.147	0.252
6. Group Assessment	0.343			(3, 18)	1.096	0.376	0.154

Table 3.
ANOVA results

Note(s): p less than 0.05 appears in italic
*applied for violated sphericity

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 and group contribution at the middle points of the challenge-based project

Exploring students' perceptions in group performance levels, we reviewed the students' perceptions on individual and group contribution in each construct at two middle points of the course.

The results from two midterm questionnaires were visualized. 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 their 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 data from the focus group to explain 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.

In the radar charts of perceptions by individual and group contributions (Group G, Figure 1), 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

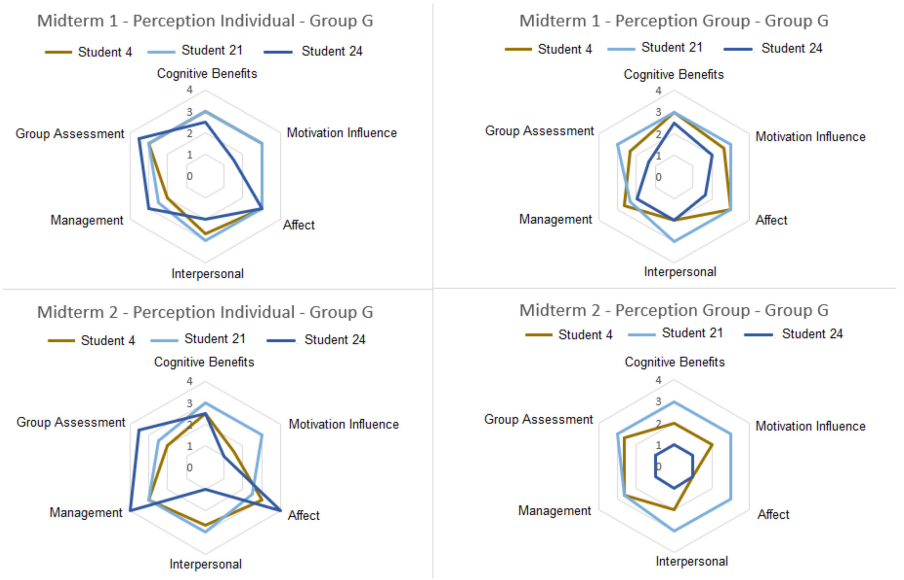

Figure 1.
Radar charts of perceptions on individual and group contributions of Group G

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.

In the second midterm, 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.

> 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 explored to gain deeper insights into students' experiences and groupwork difficulties. The findings were presented according to emergent

themes, which focused mainly on the changes of students' perceptions in multiple points in different performance levels. The students' answers in the focus group explained the respective perception changes and phenomena.

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. This was also illustrated in students' answers during the focus group. Some students in the high-performing group said they decided to stay in the group rather than drop 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(and) 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 enlightened 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. 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. (Student 32)

Secondly, the strategy in group task division 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)

Briefly, these results provided insights explaining why students' perceptions changed in the six SAGA constructs. Students in high-performing groups would likely report more positively about their experience over Motivation Influence, Interpersonal, and Management constructs because students had positive experiences, had fun together, and showed a willingness to help each other. This increased their commitment to the project and helped their group to perform better. Also, the student comments revealed the influence of time pressure and the approach used in allocating group workload on the Cognitive benefits construct.

Discussion

Challenge-based learning offers students opportunities to work together on real-life problems and gain additional knowledge and skills (Malmqvist *et al.*, 2015). However, it is challenging to engage students in meaningful learning experiences to maximize the potentials of challenge-based learning (Chang and Brickman, 2018; Phunaploy *et al.*, 2021; Suryanti and Supeni, 2019). The challenges increase even more in online settings and mixed students' feelings over groupwork (Chang and Brickman, 2018; Simon and Stauber, 2011). This research explored how students' perceptions change in online challenge-based learning in relation to group performance levels, according to Volet's (2001) SAGA instrument. Integrating the quantitative and qualitative findings, we found insights into how students' perceptions change and why these changes might have occurred.

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. No significant differences in students' perceptions before and after groupwork were found in Cognitive Benefits, Motivation Influence, Affect, and Interpersonal constructs. Previous research indicated that challenge-based learning would bring students cognitive benefits (Edelson *et al.*, 1999; Freeman *et al.*, 2014), motivation (Frank *et al.*, 2003; Green, 1998), self-learning skills, and improved peer relations (Requies *et al.*, 2018). However, our findings do not reflect all these positive impacts. 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.

Additionally, this little gain of cognitive benefits was reflected in the way students combined their individual contribution mechanically, rather than collaborating properly. Two main reasons for this behavior were mentioned in the focus group. Firstly, one reason was the task value. Specifically, because the course was an elective with pass and fail results, this contributes few credits to students' general program performance. Due to this low task value, students were unwilling to spend time and effort on the course project. Students tend to focus on extrinsic goals more than intrinsic goals to increase their self-efficacy in problem-based learning (Othman and Idrus, 2019). For the elective course, with the limitation of extrinsic goals, students would likely not spend much effort, 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 in devising the solution (Mahasneh and Alwan, 2018; Mitchell *et al.*, 2010). Time pressure limited students' chances of exploring the challenge, building team connections, and have meaningful group interactions.

Nevertheless, our findings suggest that students recognized several benefits of challenge-based learning. The perception scores on the constructs of Management and Group Assessment after groupwork being higher than the respective scores before groupwork. Our findings confirm the earlier observations about students' perceptions of utility value in challenge-based learning by

Beier *et al.* (2018). Further research on online challenge-based learning needs to be done in more control settings to provide definitive evidence.

The second research question was how students' perceptions changed in different group performance levels. We found that students in high-performing groups tend to report more positive perception scores related to Motivation Influence, Interpersonal, and Management constructs. This was explained in focus group comments where students in these high-performing groups with positive interpersonal experience and showed a willingness to help each other, which increased their project commitment and group performance. Meanwhile, further analysis indicated that dramatic decreases in Motivation Influence and Interpersonal constructs would imply an imbalanced workload among members, negative group experience, and free-riding issues. These findings might stem from the situation that students who did not experience meaningful learning 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 with the task and peers (Amulla, 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 decreasing perception scores on Motivation Influence and Interpersonal constructs.

With these results, we extend the current literature on online challenge-based learning about how students' perceptions change. Our research also made a first attempt in investigating students' perceptions in relation to group performance levels, whereas most prior studies have concentrated on the general impacts of challenge-based learning (Beier *et al.*, 2018; Edelson *et al.*, 1999; Freeman *et al.*, 2014; Frank *et al.*, 2003; Green, 1998; Requies *et al.*, 2018; Suryanti and Supeni, 2019). Our findings broadly support the prior study in identifying struggling teams through signs at the early groupwork stages (Pisoni *et al.*, 2021). It would be possible to identify struggling teams within the very first stage of groupwork with the signs shown in our midterm perception charts.

We also identified difficulties hindering students in the collaborative learning experiences, namely time and task value. Our findings raise intriguing questions over the suitable workload for group assignments given the course duration and course characteristics. Challenge-based learning requires students to organize and monitor their groupwork (Bilbao *et al.*, 2018). Problem-solving is also time-consuming (Mahasneh and Alwan, 2018; Mitchell *et al.*, 2010). Additionally, in online settings, it would take a longer time for students to notice issues negatively affecting their group performance (Simon and Stauber, 2011). Consequently, applying challenge-based learning in online time-compressed courses would risk causing cognitive overload. Hence, challenge-based learning appeared to be less appropriate for time-compressed courses. Further research is needed to better manage the cognitive load of online challenge-based courses. To minimize difficulties in groupwork, teachers can devise strategies to promote students' learning experience. These strategies could include: (1) providing students with an overview of important tasks and milestones for the group assignment to help students manage their groupwork optimally (Dao, 2020); and (2) raising students' awareness on the task value (Koh, 2020).

The study has a limitation concerning the weak reliability rates of Interpersonal and Management scales in initial questionnaires and some constructs in the midterm questionnaires. 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 items to ensure the content validity of the questionnaires. A possible second explanation for these low reliability rates might be that students interpreted the concepts in questionnaires differently. All questionnaires were self-reported. In future research, students should know about the concepts before answering the questionnaires. Despite

having the reliability limitation, the study used focus groups to collect qualitative data to enhance insights into student experiences. Overall, our findings extend the understanding of students' perceptions of online challenge-based learning in relation to performance levels and provide suggestions for teachers on how to identify struggling teams and to better design and facilitate challenge-based courses.

Conclusion

Our research is an important step towards deeper understanding of students' perceptions in online challenge-based learning. Our findings suggest that teachers could identify student groups that need help by observing students' perception scores on Motivation Influence and Interpersonal constructs, according to Volet's (2001) SAGA instrument. Students, whose perception questionnaires reveal dramatic decreases in Motivation Influence and Interpersonal, are more likely to be in groups having a low or mediocre performance in the end. Identifying these students early in the process allows the teacher to intervene or provide feedback that keeps the group process going.

Students recognized that they could learn valuable skills from experiencing challenge-based learning but experienced difficulties related to time pressure and added value of the task. Based on our results, we suggest that challenge-based learning is less appropriate for time-compressed courses. To minimize difficulties during groupwork, teachers should consider if the course and timeline are appropriate for challenge-based projects and emphasize the value of the challenge-based assignment.

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