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Constructive Feedback: A Key to Maximize Students' Motivation towards Science at Secondary Level

Rabia Aslam[1], Najmonnisa Khan[2], Ushaque Ahmed[3]
[1]Assistant Professor, University of Gwadar, Gwadar, Baluchistan, Pakistan
[2]Associate Professor, Shaheed Zulfiqar Ali Bhutto Institute of Science & Technology, Karachi, Pakistan
[3]Assessment Officer, Sindh Education Foundation, Larkana, Pakistan
*Corresponding author, email: rabia.aslam@ug.edu.pk

Abstract
The study aimed to determine the effects of constructive feedback on students' motivation toward chemistry subject across the treatment/control groups. A Quasi experimental research design was used. A purposive sampling technique was applied and 97 female students of grade IX from a public sector school were selected. The students' motivation was measured by using the Students' Motivation in Chemistry Questionnaire (SMCQ). The application of the constructive feedback exhibited a significant effect on learners' motivation in the subject of Chemistry, encompassing all five dimensions. Based on these findings, it is suggested the integration of the constructive feedback becomes an integral component of daily assessment practices within the Chemistry domain. Additionally, educators are advised to incorporate constructive feedback strategies into classroom settings nationwide. This approach holds the potential to enhance students' motivation and ultimately foster more effective learning experiences in Chemistry.

Keywords: Constructive feedback, Learning goal orientation, Critical thinking disposition, Self-efficacy, Self-regulation.

Introduction

Chemistry stands as a foundational discipline within pharmaceutical and health sciences, serving as a cornerstone for various manufacturing industries. This underscores the significance of evaluating the quality of instruction and comprehension in the subject of Chemistry at the lower secondary level, specifically in Grade IX. This grade marks the initial introduction of Chemistry as an independent subject in Pakistan (Bhutto et al., 2018). Additionally, it is worth noting that students in Pakistan exhibit lower levels of enthusiasm for Chemistry, often harboring apprehensions and perceiving it as a challenging subject (Akram et al., 2017). Consequently, they encounter difficulties in tackling their annual exams, as noted by Bhatti and Qazi (2017), leading to subpar performance in scientific assessments (Chishti & Rana, 2021; Din & Saeed, 2018). The academic achievements of students and their ability to meet learning objectives are influenced not only by the teaching techniques employed by educators but also by the caliber of feedback furnished by teachers throughout the formative assessment process (Ahmed et al., 2020; Din & Saeed, 2018). It is a very common perception in Pakistan that only "awarded marks" or "providing grades" are sufficient feedback for our students (Batool, 2020), and the schools doing these practices need to be trained in providing constructive feedback (Ghazali et al., 2020). Moreover, within the Chemistry curriculum, there exists a focus on encouraging educators to impart student-centered knowledge, aiding learners in forming a theoretical grasp of Chemistry by elucidating learning objective collaboratively (Government of Sindh, 2017; Government of Pakistan, 2006). The Chemistry curriculum also underscores the importance of nurturing self-regulation in students, empowering them to engage in autonomous thinking, inquiry, and the pursuit of answers independently (Government of Sindh, 2017, p. 1). Self-regulation is positively related to student's academic performance. However, in Pakistan, teachers follow the traditional teacher-centered approach in the teaching-learning process at the secondary level in science. Therefore, students are found to have not as much self-regulation of learning abilities as they could (Aslam & Khan, 2020). This gap can be overcome, and both the requirements of the curriculum can be achieved by integrating the constructive feedback model proposed by Hattie and Timperley in 2007 (Brooks et al., 2019).

Objective of the Study

1. To findout the effects of constructive feedback intervention on students' motivation with respect to task value , learning-goal orientation, self regulation, self efficacy, and critical thinking disposition.

Literature Review

Theoretical Framework of the Study

Many researchers conducted studies widely around the globe to investigate the role and the effects of feedback on learning. This appears to be reasonable. Socio-constructivism theory by Vygotsky (1978) perceived feedback as a conduit for the transmission of knowledge from an experienced individual to a novice counterpart, to facilitate the learning process (Brooks et al., 2019). Vygotsky's socio-constructivism theory highlights the social and cultural interactions that play a key role in the learning process. According to this theory, knowledge is co-constructed, and learners learn from each other. It is named a theory of social constructivism as learning is constructed in a social environment with the help of interaction between an expert and a novice. In this process, the experts or the adult can be a teacher guide and provide feedback on the students' tasks. An essential feature of Vygotsky's (1978) theory is the "Zone of Proximal Development (ZPD), where tasks that range

in difficulty levels for an individual to master alone but can be mastered with the assistance or guidance of adults or more skilled people, i.e., teachers". This mastery can be achieved by "Scaffolding," which provides timely assistance to the learner to complete the task. This implies that the learner can perform a task when provided feedback, and then the learner is closer to mastering it; later on, they can also perform a certain task on their own (Lundstrom & Baker, 2009). Therefore, it is important to establish an environment that supports feedback as part of the learning process, which involves an understanding of the significance of teacher-student interactions. In this way, feedback becomes an integral part of the teaching-learning process. Constructive feedback improves students' academic achievement when social constructivist theory is implemented correctly and consistently (Black & Wiliam, 2009).

Following the constructivist perspective, it explicitly says that motivation is the key component and has a big role in student learning, generally and specifically in evaluation. It could be positive or negative. One of the most recognized psychological motivation theories is the "*goal orientation theory*" given by Ames, 1992. The theory explains that there are two existing forms of learning objectives: mastery and success. Mastery goals center on nurturing the development of fresh skills, enhancing understanding of assignments, elevating cognitive capabilities, or fostering a sense of mastery-driven self-perceptions (p. 262). Conversely, performance goals steer younger individuals towards achieving higher grades or attaining praise and recognition from the public for their accomplishments. Ames (1992) corroborates that mastery goals hold greater significance compared to performance goals, as they not only stimulate students but also fuel their creativity and enthusiasm for learning (Zahroh et al., 2020).

According to Brandtsta¨dter and Rothermund (2002), two important factors influencing engagement are subjective attainability and personal belief or importance. Moreover, both factors are aligned with the *expectancy-value theory (EVT)* of achievement and motivation (Eccles & Wigfield, 2002). According to this theory, individuals' expectancies and values directly influence performance and task choice. Success choice depends on the expectation of success, and the value of the goal is influenced by beliefs, difficulties, and self-planning (Eccles & Wigfield, 2002). Students face difficulties in making realistic goal-setting about certain tasks and face difficulty evaluating the attainable outcomes due to a lack of knowledge. To overcome these obstacles, students seek guidance in feedback from their teachers on whether they are in the right direction toward achieving their goals (Aslam & Khan, 2020; Hattie & Timperley, 2007; Wigfield, 1994). Even if the feedback is available, some students ignore it, and they persist despite feedback that the goal is unattainable. Again, self-efficacy and value to a certain task have influenced the acceptance of feedback. Aslam and Khan (2020) claimed that "*when learners are convinced that they have essential, informative learning goals, then learners must take into account feedback as a beneficial for the accomplishment of the task; and their motivation to involve in a self-regulated learning will most likely be enhanced"* (p. 185).

Self-efficacy and self-regulation are two main components in *Bandura's social cognitive theory (1997)* that affect motivational outcomes. Learners who are efficient in learning are suited to participate in learning and behaviors, such as setting objectives, employing effective learning techniques, monitoring, and assessing progress toward their objective, and building effective physical and social learning settings (Schunk & DiBenedetto, 2020). Self-efficacy and self-regulation do not emerge suddenly. Efficacy involves a cognitive process through which individuals utilize sources of information, i.e., performance accomplishment, to assess their self-efficacy (Bandura, 1997). Performance accomplishment is one of the most reliable sources, indicating what one can achieve (Schunk & DiBenedetto, 2020). Similarly, social cognitive theory claims that individuals use their self-regulatory capabilities to accomplish a certain task. Self-efficacy and Self-regulation are influenced by the consequences of actions, including factors like perceived progress toward goals and levels of achievement and the environmental inputs, e.g., teachers' feedback (Schunk & DiBenedetto, 2020).

The cognitive, constructive self-regulation theoretical account has three submeasures, self-observation, evaluation, and response. Learners take part in learning programs with clear targets like acquiring information and abilities and finishing assignments. Keeping in mind the targets, they notice, evaluate, and respond to their apparent development toward their objectives. Modern constructive and self-regulatory feedback strategies consider a student a productive source in achieving, explaining, and applying feedback (Thurlings et al., 2013).

In this research, the researcher connects goal-oriented theory to assessment, achievement objectives for summative, and mastery objectives for formative purposes. Mastery objectives are the important distinctive characteristics of formative appraisals and are concerned with comprehending the content. On the other hand, success objectives are relevant to the summative purpose, and they focus only on abilities and getting good grades. As a result, this gives a sense that formative feedback is better than summative feedback because it amplifies the student's motivation throughout the learning journey. Despite being widely acknowledged as beneficial for students' learning, formative feedback, and formative assessment are significant contributors to this process, so it is very important to understand that "formative assessment is not only dependent on task learning and subsequent response but, it has the broader view and involves motivation and students' self-perception". Expectancy-value theory (EVT) highlights the critical part of academic tasks that create student's interest. Eccles and Wigfield (2002) explained the EVT and emphasized the main functions of task value for the learner's assumptions for progress, choices, and outcomes relevant to the achievement.

Furthermore, Zimmerman (2002) mentioned that even when learners have low self-efficacy but give importance to learning activities, their contributions will probably begin and continue. Thurlings et al. (2013) claimed that Meta-Cognitivism emphasizes that learners acquire how to learn. Self-regulated learning fits into this learning theory. In the self-regulated learning process, "*learners have their own responsibility to learn. This means the feedback process starts with the learners. Afterward, feedback is provided by the teacher, and then the learner stream on to another level. This cyclic process gives a new starting point to the students, and the process of feedback goes on*" (p. 4).

Moreover, they added and explained that learner's active involvement in developing their knowledge and information is the main focus of social constructivism. The initial phase of learning is the prior support given by the teachers in the form of feedback, in which learning occurs by examining various examples. This is an interactive process, peers are involved, and students work collectively. This shows that feedback starts from the end of learners. Once teachers provide their feedback, the ongoing learning process propels learners into a subsequent stage, effectively marking a fresh starting point (Thurlings et al., 2013: p. 4).

Receiving constructive feedback has been related to increased success, motivation, and self-efficacy. It allows students to participate actively in their education, which can help students with lower abilities achieve more (Bandura, 1997). Constructive feedback can also help students gain the skills to become self-regulators (Aslam & Khan, 2020). However, students must be active and engaged participants in their learning to make the most of any resources designed to enhance their learning experience.

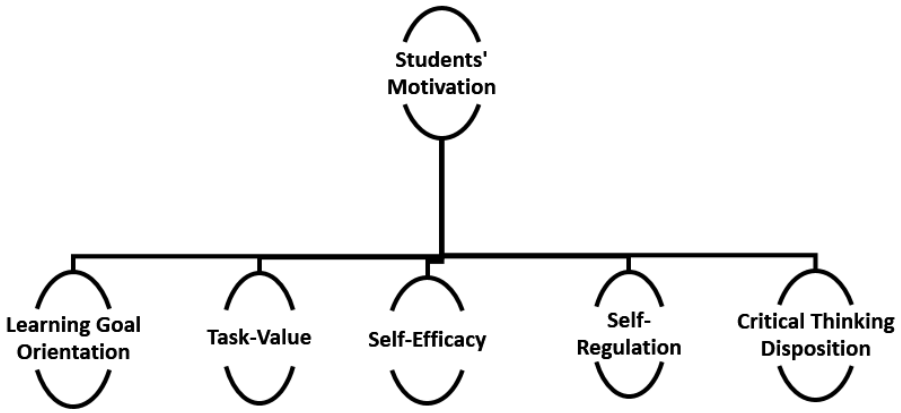
Self-regulation or self-control and motivation are interconnected. Feedback is a crucial stimulus for self-control (Zahroh et al., 2020). Setting goals, self-efficacy, and outcome expectations are all essential motivational variables that influence self-regulation. Participating in successful self-regulated learning can motivate students to set new goals and continue to learn. Beliefs, aspirations, and assistance in the quest for, i.e., constructive feedback from the teacher, are some of the driving factors involved in self-regulation. As students make adoptions about comfort, location, learning outcomes, and timings, these variables will work together to determine whether or not getting behavior is initiated and sustained.

Students' Motivational Constructs in Science Subject

A motivational construct is usually associated with a latent variable; an assumed causal variable reflects a non-observable scale (Kline, 2011). As a result, a construct can only be evaluated indirectly; this is done by evaluating those objects that show how the participant conceptualizes the construct empirically. The conceptualizations of students are important because they can affect their behaviour (Scott et al., 2007). Many researches have recently engrossed on designing motivating scales for students to learn science (Tuan et al., 2005; Velayutham et al., 2011). In 2005, Tuan and her colleagues developed the "*Students' Motivation towards Science Learning (SMTSL) questionnaire*" and validated it with high school students in central Taiwan. Six motivational constructs were identified in the SMTSL questionnaire; active learning strategy, self-efficacy, science learning value, achievement goal, performance goal, and stimulation of learning environment, and were used to assess the improvement in students' learning motivations after the initiation of practical tasks in a chemistry course. However, some constructs of the SMTSL questionnaire were not theoretically sound and were found ambiguous by the developer (Tuan et al., 2005). Velayutham and her colleagues in 2011 created the *Students' Adaptive Learning Engagement in Science questionnaire*, which is focused on theoretical and research foundations. Four constructs emerged from the validation process: learning goal orientation, task value, self-efficacy, and self-regulation (Velayutham et al., 2011).

Another aspect of a student's personality, critical thinking disposition, has recently received attention in studies on students' motivation and achievement toward Chemistry (Sadhu & Laksono, 2018). From a practical point of view, critical thinking has an interdependent relationship with disposition. Critical thinking skills without motivation are useless. Students who are motivated will think critically (Stupnisky et al., 2008). Therefore, Arsal (2017) validated and described it as an important construct of students' motivation towards the Chemistry subject. Hence, the following five motivation constructs (Figure 1) are included in the final version of the Students' Motivation in Chemistry questionnaire (SMCQ): learning-goal orientation (LGO), task-values (TV), self efficacy (SE), self regulation (SR), and a critical thinking disposition (CTD). These constructs have been considered useful for evaluating the motivation in scientific and non scientific subjects.

Figure 1.
Constructs of Students' Motivation



Research Methodology

Method & Procedure
The present study was grounded in the post-positivist paradigm, which postulates that the observable world can be studied, and interpreted, and results can be generalized to a broader population. The researcher used the quantitative approach. The research applied a Quasi-experimental design in which the experiment was done as a "Pre-test Post-test" with the "Control and Experimental Group" (Creswell & Creswell, 2017). The population of the study comprises all female students for the academic year 2020-2021. This study was conducted on Grade IX students studying Chemistry within govt. girls' higher secondary school located in the district of Karachi, Pakistan. A specific potential public school in Karachi was chosen through purposive sampling to carry out the intervention. The research scope encompassed 4 sections of Grade IX within that school. A total of 97 Grade IX students participated, with 48 students being assigned to the experimental group and 49 to the control group. The experimental group received constructive feedback, while the control group received conventional feedback comments. The research was conducted as a single-blind experiment, with the students unaware of their group assignments.

Instrument
Constructive feedback effects on students' motivation were measured using "S*tudents' Motivation in the Chemistry Questionnaire (SMCQ)*" developed by Velayutham et al. in 2011. This questionnaire was further translated into the local language, i.e. Urdu, for students' better understanding of the items. The SMCQ was administered twice – as a pre-test and a post-test – both before and after the intervention. The tool used the same set of items for both the pretest and posttest, with the only variation being the reordering of the items in the posttest phase.
Students' motivation in the Chemistry questionnaire (SMCQ) consists of two parts: Demographic information and students' motivation scale. In demographic, participant names were asked. Students' motivation scale consists of 25 items with five constructs; learning-goal orientation (LGO)-3 items; task value (TV)-5 items; self efficacy (SE)-4 items; self regulation (SR)- 8 items and a critical thinking disposition (CTD)-5 items. All were measured on a 5-point Likert scale ranging from 1= strongly disagree to 5 = strongly agree.

Pilot Testing of SMCQ
Johanson and Brooks (2010) suggested that to analyse the data using parametric statistics, a minimum of 30 cases can be used as a rule of thumb for determining sample size. Therefore, the sample size of this pilot study was 47 female students who are pursuing Chemistry as their major subject in Grade IX. The research site for the pilot study and the research site for intervention have the same characteristics; both are located in the same town, and both are girls' higher secondary schools.
Initially, students' motivation scale consists of 40 items with five constructs; learning goal orientation (LGO)-8 items; task value (TV)-8 items; self-efficacy (SE)-11 items; self-regulation (SR)- 8 items and critical thinking disposition (CTD)-5 items, but after exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), 5 items from LGO, 3 items from TV and 7 items from SE were removed as they were not showing proper outer loading into factor. All the items of SR and CTD were retained (ref. Table 1).
The instrument exhibited a reliability coefficient of 0.905, surpassing the threshold of 0.7, which is indicative of its reliability and consistency (Hair et al., 2011). Furthermore, the subsequent paragraph delves into the discourse on convergent and discriminant validity.

Convergent Validity of SMCQ

Model convergent validity is shown in Table 2. Cronbach's alpha, outer loading, composite reliability, and Average Variance Extracted (AVE) values are used to esrtablished convergent reliability. According to Hair et al. (2011), values of indicator outer loading and AVE should be greater than 0.5, Cronbach's alpha value should be more than 0.7, and composite reliabilitry should be more than Cronbach's Alpha value. Table 2 illustrates that our all relevant items meet this set of criteria and therefore confirms convergent validity of SMCQ.

Discriminant Validity of SMCQ

Fornell and Larcker Criteria is used to confirm discriminate constructs' validity. According to this criteria, "the AVE value of a giveb construct should be greater than the square root of the correlations among different constructs" (Fornell & Larker, 1981). Table 3 shows the discriminate validity of the constructs and it can be seen the AVE value for each construct is greater than the corresponding correlation among the construct, thus, discriminate validity of the SMCQ confirmed from this outcome.

Intervention

The experiment was designed to span a duration of three months, encompassing a total of thirteen weeks, which translates to 77 working days (from September 21, 2020 to December 19, 2020). The application of constructive feedback took place within 77 class sessions, each lasting thirty minutes, occurring six days a week (Monday to Saturday). Throughout this intervention period, instruction covered five chapters from the Grade IX Chemistry Sindh Text Book Board curriculum. It's important to note that both the experimental and control groups were instructed with identical content delivered by the same teachers. The researcher diligently adhered to ethical guidelines throughout the intervention process.

Table 1.

Dimensions and Reliability of SMCQ

Variable	Dimension	Before Factors Analysis		After Factors Analysis	
		No. of Items	Alpha Reliability	No. of Items	Alpha Reliability
Motivation in Chemistry	LGO	8	.951	3	.937
	TV	8	.866	5	.859
	SE	11	.829	4	.860
	SR	8	.906	8	.906
	CTD	5	.858	5	.858
	Total	40	.896	25	.905

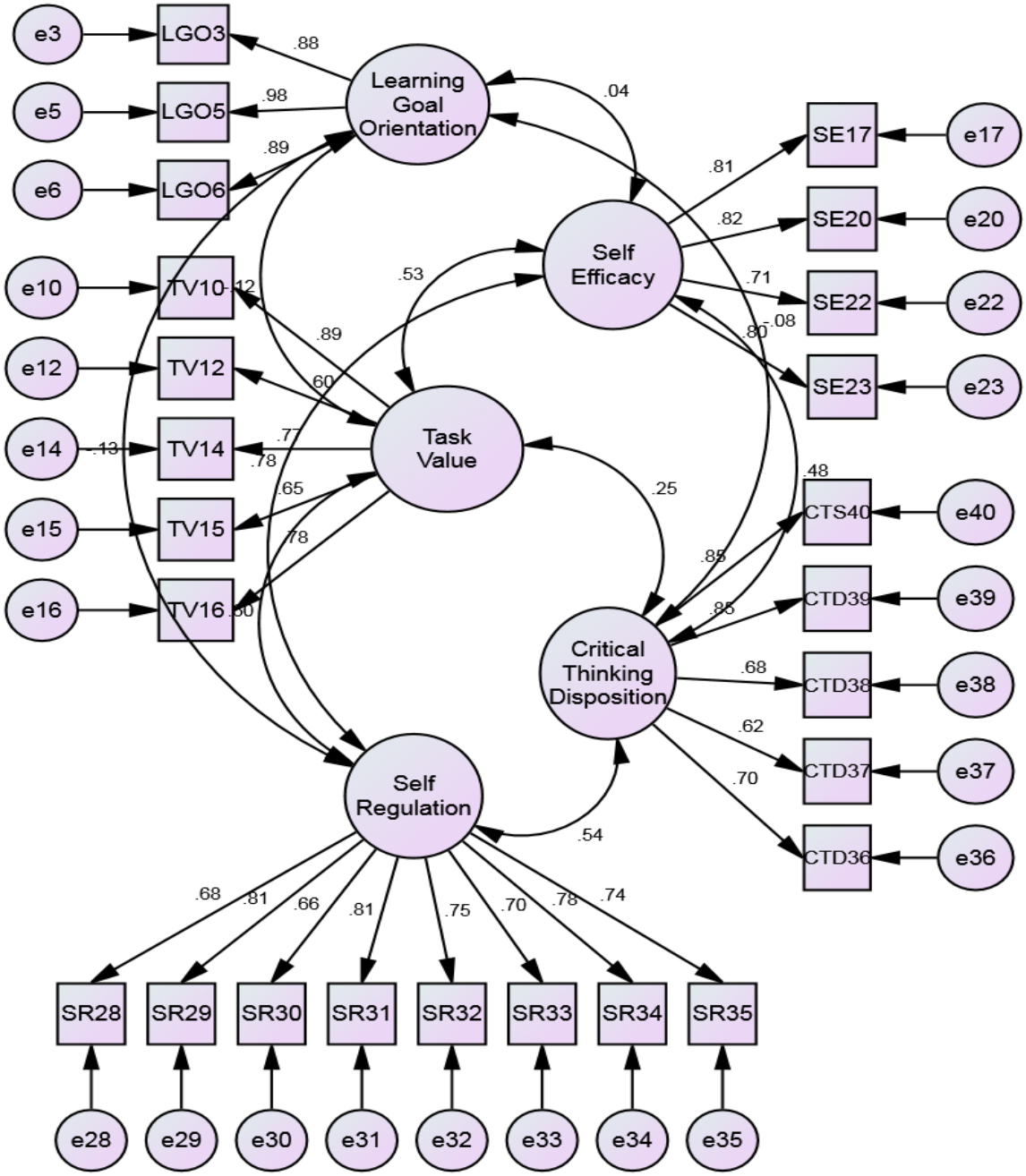
Table 2.
Convergent Validity of SMCQ

Construct	Indicators	Loadings	Cronbach's Alpha	Composite Reliability	AVE
Learning goal orientation	LGO_3	.88	.937	.941	.842
	LGO_5	.98			
	LGO_6	.89			
Task Value	TV_2	.89	.859	.861	.558
	TV_4	.61			
	TV_6	.77			
	TV_7	.65			
	TV_8	.78			
Self-Efficacy	SE_1	.81	.860	.866	.618
	SE_4	.82			
	SE_6	.71			
	SE_7	.80			
Self-Regulation	SR_1	.68	.906	.908	.552
	SR _2	.81			
	SR _3	.66			
	SR _4	.81			
	SR _5	.75			
	SR_6	.70			
	SR _7	.78			
	SR _8	.74			
Critical thinking disposition	CTD_1	.70	.858	.861	.556
	CTD _2	.62			
	CTD _3	.68			
	CTD _4	.85			
	CTD _5	.85			

Table 3.
Discriminant Validity (Fornell-Larcker Criterion) of SMCQ

	LGO	TV	SE	SR	CTD
LGO	**.917**				
TV	.536	**.747**			
SE	.607	.460	**.786**		
SR	.759	.505	.655	**.743**	
CTD	.705	.652	.594	.523	**.746**

Figure 2.
Path diagram of SEM for SMCQ



Hypotheses Testing
Students' Motivation towards Chemistry subject
H_0: Mean motivation scores of the participants who received constructive feedback are the same as those who received traditional feedback.

Table 4.
Descriptive Statistics of Pre and Post-motivation Scores in Chemistry with Control and Experimental Group

Dimensions	Group	N	Pretest		Posttest	
			Mean	Std. Dev.	Mean	Std. Dev.
LGO	E	48	3.9375	.84119	4.5069	.33679
	C	49	3.9558	.87054	4.1224	.72551
TV	E	48	3.9083	.80842	4.5896	.22048
	C	49	4.0163	.88113	4.1653	.57065
SE	E	48	3.9323	.76621	4.5260	.29282
	C	49	4.0408	.67959	4.3214	.49739
SR	E	48	3.8177	.78802	4.4557	.20384
	C	49	3.8571	.70295	4.0255	.53338
CTD	E	48	3.3448	1.00675	4.1104	.64155
	C	49	3.3143	.85829	3.6310	.87587
Overall Motivation	E	48	3.7777	.58823	4.4377	.20923
	C	49	3.8307	.50163	4.0531	.42047

Note. Initially, 120 students participated in the study: 60 students in the control group and 60 students in the treatment group. Due to attrition and some incomplete scores for either academic achievement tests or motivation scale subsets, some participants were not included in the analysis. 97 students had pre and post-test scores in the academic achievement test or motivation scale subsets: 49 students were in the control group and 48 in the treatment group.

Table 5.
Group-based Differences in Students' Motivation

Dimensions	Pretest			Posttest		
	T	df	Sig. (2-tailed)	t	df	Sig. (2-tailed)
LGO	-.105	95	.916	3.359	68.076	.001
TV	-.629	95	.531	4.848	62.267	.000
SE	-.738	95	.462	2.475	78.002	.015
SR	-.260	95	.795	5.267	61.973	.000
CTD	.161	95	.873	3.080	88.014	.003
Overall Motivation	-.478	95	.634	5.721	70.719	.000

Independent sample t-test was applied to test the null hypothesis, whether there is a significant difference in mean motivation scores of the participants who received constructive feedback compared to those who received traditional feedback. Table 4 shows the descriptive statistics of pre and post-scores of students' motivation in chemistry (SMCQ) with the control and experimental group. Table 5 shows group-wise significant differences in mean motivation scores. The mean value of pre-SMCQ of the control group (M = 3.8307, S.D = .50163) and experimental group mean value (M = 3.7777, S.D = .58823), t (95) = −.478, p > 0.005, shows that both the groups are equal. In post motivation test, control group mean value (M = 4.0531, S.D = .4207), t (71) = 5.721, p < 0.005 is much lesser than mean value of the experimental group (M = 4.4377, S.D = .20923), shows a significant change in the motivation level of the experimental group with compare to the control group.

Mean value of pre-LGO of the control group (M = 3.9558, S.D = .87054) and mean value of the experimental group (M = 3.9375, S.D = .84119), t (95) = −.105, p > 0.005 shows that both the groups are equal. Control group mean value of post LGO test (M = 4.1224, S.D = .72551) is much lesser than experimental group's mean value (M = 4.5069, S.D = .33679), t (68) = 3.359, p is less than 0.005 which shows a significant change in the motivation level in term of learning goal orientation of experimental group with compare to the control group.

Mean value of pre-TV of the control group (M = 4.0163, S.D = .88113) and experimental group mean value (M = 3.9083, S.D = .80842), t (95) = −.629, p > 0.005 shows that both the groups are equal.Mean value of control group in post TV test (M = 4.1653, S.D = .57065) is much lesser than the experimental group's mean value (M = 4.5896, S.D = .22048), t (62) = 4.848, p is less than 0.005 which shows a significant variation in the motivation level in term of task value of experimental group with compare to control group.

Mean value of pre-SE of control group is M = 4.0408, S.D = .67959 and mean value of experimental group is M = 3.9323, S.D = .76621, t (95) = −.738, p > 0.005, shows that both the groups are equal. In the post SE, mean value of control group is M = 4.3214, S.D = .49739, which is much lesser than tmean value of the experimental group i.e. M = 4.5260, S.D = .29282, t (78) = 2.475, p less than 0.005, shows a significant variation in the motivation level in term of students' self-efficacy.

The mean value of pre SR of control group i.e. M = 3.8571, S.D = .70295 and mean value of experimental group i.e. M = 3.8177, S.D = .78802, t (95) = −.260, p > 0.005 shows that both the groups are almost equal. In the post SR test, the mean

value of the control group (M = 4.0255, S.D = .53338) is much lesser than the mean value of the experimental group (M = 4.4557, S.D = .20384), t (62) = 5.267, p is less than 0.005 which shows a significant variation in the motivation level in term of students' self-regulation of the experimental group with compare to the control group.
Mean value of pre-CTD of the control group (M = 3.3143, S.D = .85829) and the mean value of the experimental group (M = 3.3448, S.D = 1.00675), t (95) = .161, p > 0.005 shows that both the groups are equal. In the post CTD test, the mean value of the control group (M = 3.6310, S.D = .87587) is much lesser than a mean value of experimental group (M = 4.1104, S.D = .64155), t (88) = 3.080, p is less than 0.005 which shows a significant change in the motivation level in term of students' critical thinking disposition in chemistry subject of the experimental group with compare to the control group.

Discussions

Constructive Feedback and Students' Motivation

The objective of the study was to find out the effects of constructive feedback intervention on students' motivation across the control/experimental groups. The motivation was measured in terms of LGO, TV, SE, SR, and CTD. The result of the study found that the intervention of constructive feedback is statistically significant, which shows that the overall motivation post-test scores of the experimental group differ from the motivation post-test scores of the control group while adjusting the pre-test scores in the same measure. Effective delivery of feedback possesses the capacity to elevate effort, motivation, and engagement among learners (Sadler, 1998). This observation is corroborated by the research, which asserts that the constructive feedback stimulates students, enhance their learning, and help in their professional growth (Omer & Abdularhim (2017). Notably, Deci and Ryan (1985) argue that quality feedback has the potential to enhance students' self perceptions of their competence and bolster their motivation to actively engage in the learning process, although the feedback must be successfully assimilated to yield its desired effects. The study conducted by Kiemer et al. (2015) arrived at a similar conclusion, indicating that constructive feedback heightened students' sense of competence and motivation to learn. Schillings et al. (2020) further affirmed that teachers' provision of feedback was instrumental in improving students' comprehension of assessment criteria (feed-back) and furnishing constructive recommendations for progress (feed-forward). It is worth noting that written feedback dispensed by adept educators was identified as a pivotal factor in enhancing students' motivation and their grasp of strategies for enhancing their academic writing assignments.

Constructive Feedback and Students' Learning Goal Orientation

The first dimension of motivation in the study was learning goal orientation (LGO). Findings showed that the intervention of constructive feedback is statistically significant. Black and Wiliam (2009) discovered that students are able to self-assess effectively only when they possess a well-defined understanding of the learning objectives they are expected to achieve. In the absence of explicit formative assessment goals, students struggle to identify their learning deficiencies and are consequently unable to address those gaps (Black & Wiliam, 2009). The students' learning goal orientation is likely to affect a variety of positive learning outcomes, including student achievement (Brooks et al., 2019). Feedback is not delivered clearly between teachers and students if there is a lack of clarity of goals and standards (Black & Wiliam, 2009; Sadler, 1998).

Constructive Feedback and Students' Task-Value

The second domain of motivation in the study was task-value (TV). Findings suggested that the intervention is statistically significant. Achievement-based feedback has been identified as a significant influence in research on the antecedents of task-value. Students' scores or grades positively or negatively predict task value in different academic domains (Gniewosz et al., 2015). Students who consider their learning experience to be meaningful and significant were engaged more cognitively in putting efforts to learn and appreciate the materials provided to them (Pintrich & DeGroot, 1990). According to Black and Wiliam (2009), feedback related to the task was more impactful than feedback focused on the student, even if the latter included praise. Notably, ego-involving feedback had adverse outcomes in certain scenarios. Moreover, feedback delivered at the task and process levels demonstrated optimum effectiveness when the information provided was directly aligned with the objective of the lesson (Hattie & Timperley, 2007). Feedback wields a prominent influence on students' perception of the value of a task and academic feedback (Gniewosz et al., 2015).

Constructive Feedback and Students' Self-Efficacy

The study's third area of focus regarding motivation was self-efficacy (SE). The outcomes of the current research substantiate that the implementation of constructive feedback yields statistically significant results in relation to self-efficacy. The construct of self-efficacy is a significant factor in the educational performance (Bandura, 1997) of a wide range of chemistry students. Students' self-efficacy beliefs play a pivotal role in shaping aspects like motivation, self-reliance, self-regulation, and academic achievements (Ahn & Bong, 2019). Proficient teacher feedback contributes to nurturing a student's confidence in their capabilities, exerting a substantial influence on the student's learning journey (Hussain et al., 2017).

Constructive Feedback and Students' Self-Regulation.

The fourth domain of motivation in the study was self-regulation (SR). The present study's findings suggested that the intervention of feedback is statistically significant. The interconnections between feedback and self-regulation of learning, however, have all been found in Carless et al. (2011), Hattie and Timperley (2007), and Espasa and Menses (2010); and their findings resound with Hemerda's (2016) observation that "exterior feedback is likely to influence students' knowledge in terms of complexity and importance of self-regulation" (p. 43). Feedback serves as a pivotal catalyst for fostering self-regulation (VanLoon & Roebers, 2017). In a reciprocal manner, self-regulation is intertwined with academic motivation and heightened levels of achievement. The insights derived from feedback enable students to comprehend their progress vis-à-vis predetermined objectives. Consequently, this process steers their future goal selection and enhances their awareness of requisite strategies for attainment. Proficient learners often define objectives, choose strategies that align with the situation, and harness feedback to oversee their learning journey. This feedback can either originate externally or be self-generated (VanLoon & Roebers, 2017).

Constructive Feedback and Students' Critical Thinking Disposition

The fifth domain of motivation in the study was critical thinking disposition (CTD). Findings suggests that CTD post-test scores of the experimental group differ from the control group's CTD post-test scores while adjusting the pre-test scores in the same measure. Critical thinking is incomplete without teachers' constructive feedback (Hsiao et al., 2017). Although, Arsal's (2017) findings contradict that teachers' feedback is not an effective method to enhance students' critical thinking disposition. Whereas students' critical thinking disposition has a strong relationship with CGPA, teachers can effectively engage students by providing them constructive feedback (Batool, 2020). Facilitating analytical assignments, fostering a focus on creativity, delivering constructive feedback on assignments, and making answers accessible to fellow students all contribute to the enhancement of critical thinking skills (Gharib et al., 2016).

Conclusion

This study aims to enrich the current understanding of the subject matter by investigating the impact of the constructive feedback on both students' educational accomplishments with motivation. This investigation encompasses dimensions such as LGO, TV, SE, SR, and CTD within the context of the Chemistry subject. Notably, the study places a distinct emphasis on secondary schools within the public sector. Through its dedicated focus, this research endeavors to contribute valuable insights to the existing body of knowledge in this domain. It is clear from the findings that there is a significant difference between the mean values of motivation posttest of both control and experimental groups, which further supports that constructive feedback is more effective in increasing students' motivation towards Chemistry subject at grade IX. Constructive feedback practices will provide insight not only to the high-score achiever students but also low scores achiever students would also be able to answer "Where am I going?", "How am I going?" and "What do I have to do next?". The present study will also help students be goal-oriented in their learning, take an interest in the task, boost their self-efficacy, and become more regulated towards achieving goals. This study will also help students change their behaviors to solve problems and make decisions effectively. This study will be beneficial for students and the teachers, headmistress, top-level executives, and policymakers because it will provide them with more knowledge about essential factors influencing the teaching-learning process. Secondary school teachers would be more aware of the importance of motivating students through constructive feedback. The findings may contribute to plans for teachers' ongoing professional development in terms of constructive feedback. The study will also be significant because it will enable researchers to assess the impact of the student's motivation on students' academic achievement. This research will also help teachers to obtain professional knowledge on giving constructive feedback.

Recommendations

Based on the findings of the present study, the following way forwards are suggested.

1. The implementation of constructive feedback was executed within a girls' school. There exists the potential to extend this intervention to boys' schools, enabling a comparative analysis to explore potential gender-based influences on the intervention's outcomes.
2. The scope of this study was confined to the Grade IX Chemistry subject. There is an avenue for future research to contemplate extending the intervention to encompass other subjects and diverse grade levels. This expansion would facilitate the investigation of potential impacts arising from variations in age and subject matter on the effectiveness of the intervention.
3. The study was also limited to the effects of constructive feedback on students' performance and their motivation; in the future, it is recommended to find the effects of constructive feedback on students' 21st-century skills.

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