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Interaction between Feedback Types of Interactive Videos Used in Flipped Classroom and Learning Styles of Talented Students in Developing Personal Knowledge Management Skills and Achievement

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Abstract—This study aims at exploring Interactive Videos (IV) used in Flipped Classroom (FC) and their feedback types and Learning Styles (LS) of Talented Students (TS) in developing Personal Knowledge Management Skills (PKMS) and achievement. The study was conducted on 51 STS from Hail Gifted Care Center in KSA, where they divided into four experimental groups depending on their LS and IV's feedback. The study occurred during the first term of the academic year 2019–2020. In the FC based on IV, no statistical differences between the TF and AF were present in interactive videos on the achievement or PKMS for talented students. Also, no statistical differences between the LS (convergent–distant) in the total PKMS and achievement for STS were present when applying interactive videos–based flipped classrooms, same for statistical interaction effects between the TF–AF, save for some interaction effects in some knowledge management skills (conveying, analysis, organizing). Future research could address the diminishing motivation incurred with the interactive videos-based flipped classrooms. Specifically, how to design IV–based FCs with feedback types that encourage students to develop KPMS

Keywords— Feedback; Interactive Videos (IV); Flipped Classroom (FC); Learning Styles (LS); Science-Talented Students (STS); Personal Knowledge Management Skills (PKMS); Achievement.

I. Introduction

Despite the many efforts to support gifted students, they do not receive adequate services for their learning needs in the regular classroom [1]. We may know what works for gifted education in more traditional settings, yet the lack of research on online learning means knowledge about the efficacy of online learning for the gifted is impaired [2].

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Many talented students miss out on their full potential unless the curriculum responds to their needs and stimulates their thinking. Several studies on gifted students point to a connection between learning styles and classroom performance [3]. Talented students' LS differ from general population students, where talented students prefer instructional methods emphasizing independence (independent study, discussion) [4]. Students must be encouraged to "stretch" their LS to be empowered in a variety of learning situations [5]. LS plays contributed to classroom performance and the way gifted middle school students respond to their classroom [6];[1]. Without appropriately stimulating environments, gifted students become frustrated, bored, and unmotivated [1]. Although technology by itself may not be motivating, the opportunities that technology presents and motivation for TS seem to correlate. When technology aligns with authentic or "real-world" applications, motivation can surge [7];[8]. Technology can effectively accelerate coursework to exceptional middle school students, effecting cost-effectiveness, parent and student satisfaction, and individualized talent-focused work pace [2].

Educators worldwide are promoting a blended-learning environment that combines technology

with traditional teaching. Flipped classrooms follow the concept of a blended-learning strategy that has recently gained popularity [9]. In this pedagogical approach, the students work independently outside the classroom to study basic concepts through different methods like online lectures, videos, and articles. The learning is self-paced; the classroom time is then used for the application of the learned material in the class. The students engage in activities focusing on the development of skills of concepts application and factual knowledge they have acquired earlier [10]; [11]; [12].

Governments encourage the use of video-based FC by funding schools, enabling the implementation of FC [13]. Students suggested that teacher's footage and surprise questions should be included in interactive videos [14].

Several advantages of FC were reported as the: increased understanding, the development of critical and higher-level thinking, self-regulated learning, collaborative work, and face-to-face interaction with the lecturer [15]; [16]; [17]; [18]; [11]; [19].

Interactive videos are a recent addition to flipped learning, allowing students to actively engage with the teaching material rather than passively watching it [20]. These videos contain embedded interactive activities, e.g., quizzes and open questions, to somehow engage students [21]. Video-based FC instruction can strengthen learning motivation [9:387], thus providing theoretically sound deep learning for students of different abilities [9:388]. Interactive videos raise the motivation and intrigue learners, availing effective learning. Interactive videos perpetually prompt the learner to interact with the program during the presentation with the possibility of providing feedback actively [22]; [23].

The benefits of video-based FC instruction assume that all learners are motivated and self-regulated to complete the assigned learning tasks outside class time. [24].

Providing gifted learners with appropriate choices for accelerated coursework in their area of talent or interest in this type of blended-learning model can help them meet their potential for academic achievement [2].

To succeed in today's information-oriented environment, knowledge uses the need to exercise information literacy skills [25]. This increasing shift towards the adoption of personal knowledge skills. Ineffective PKM practices are mostly caused by the lack of correct technology-associated skills; individuals can only exercise PKM optimally with effective technology-related skills [26]; [27].

one key purpose of PKM is to provide a framework for individuals to manage and integrate new information and enrich their knowledge database effectively, thus empowering individuals to easily apply their knowledge to handle new and old problems and learn from new experiences. It is one of the needs of the gifted students that many types of research had mentioned [28].

PKMS' importance has been addressed by many researchers [29]; [30]. It helps individuals with knowledge creation, management, and application. It is not easy helping students to manage their knowledge efficiently, especially in online courses. The key issues are managing and supporting personal knowledge and information so that it is accessible, meaningful and valuable to the individual; maintaining networks, contacts, and communities; making life easier and more enjoyable; and exploiting personal capital [31]; [30]. Technology-enhanced individual prowess is a critical part of PKM, and such technology will help users to classify information and archive interactions, emails, and other items to easily locate them [26:334]; [32].

Literature Review

Literature suggests that while blended-learning programs are a growing segment of online learning in K-12 schools that can facilitate a wider variety of benefits for extending gifted programming, very little has been documented about the role and effectiveness of blended-learning in a gifted-students classroom, and none of this literature is empirical [2:295].

Gifted education in KSA has been under the leadership of two main institutions: Mawhiba and the Ministry of Education. Many of the enrichment services that are offered in schools and summer enrichment programs in KSA are based on the Oasis Enrichment Model. Due to the nature of the education system in KSA, the administration of the

model mostly employed a pullout approach, where gifted students are gathered together outside the mainstream classes to join systematic enrichment programs either during the academic year or during the summer vacation [33].

Flipped Classroom

A FC approach comprises two distinct parts: direct online instruction at the students' own time and pace and interactive group learning activities in scheduled classes [34]; [35]. Many of FC's underlying principles and techniques (active learning, student-centered instruction, self-directed inquiry, peer instruction, and constructivist learning theory) were thoroughly researched and used successfully for decades [36]; [37]. Students recognized that FCs were more efficient than traditional approaches [16:1466]; [17:80]; [18]; [19].

Interactive Videos–Based FC Advantages

Interactive components, e.g., quizzes or online exercises, should be included when creating online videos because interactive videos can be enriched, or "annotated", with other media types, i.e., texts, pictures, audios, and videos [38], but interactive videos are usually snippets of animations [39]. Videos have become crucial in modern educational systems [40]. IVs was described as one of the most exciting types of media that combines the power of moving images, story, depth, and richness of information enriched with interactivity [41]. It combines the capabilities and characteristics of video and computer within the learner's control, whether in operation, access to learning resources, or choosing the required sequences from video, audio, texts, drawings, or pictures [42].

Interactive videos are defined as video programs divided into small parts consisting of kinematic sequences and fixed frames, questions and lists, and the learner's responses via the computer, which are the determinant of the number of video clip sequences; IVs are a combination of video and computer technology where a computer is used to interact with information to provide an interactive environment enabling the learner to control video [43]; [44]; [45].

IV–based FC has been claimed to show the following advantages [9]; [16]; [11]: (1) Online assessment helps teachers determine students' level of understanding before attendance; teachers can appropriate to that level, improving class discussion and exercises. (2) It helps deal with individual differences in learning; weak learners can replay the videos and redo the assessments per their learning needs until they can fully understand the contents. (3) Post-viewing reflective activities can be developed for formative assessment purposes enabling the lecturer to ensure the following workshop activities meet the specific learning needs of the students. (4) More of the learning responsibility is transferred to the student. (5) It is flexible to cover a wider range of materials.

According to research findings IV could be used in FC to engage, motivate, allows full attention, and improve their learning, There are many tools for creating IV [46];[47];[48]. Free educational website for educators and learners (TED-Ed platform, Play posit platform).

Feedback in IV

IVs are related to various types of interaction. Feedback can be provided to the learner, ensuring they are on track and achieve the proficiency required. Feedback is the information sent to the learner to modify thinking or behavior and improve learning [49]. Feedback, functionally, is a two-parameter evaluation process: the goal and the level to be reached.

Feedback can be recognized as the process of providing the learner with information about his response in an organized and continuous manner to help them with the necessary amends for the correct response [50]; [51].

Previous studies' showed that classifications of feedback types can be summarized in figure 1. [52]; [53]; [54].

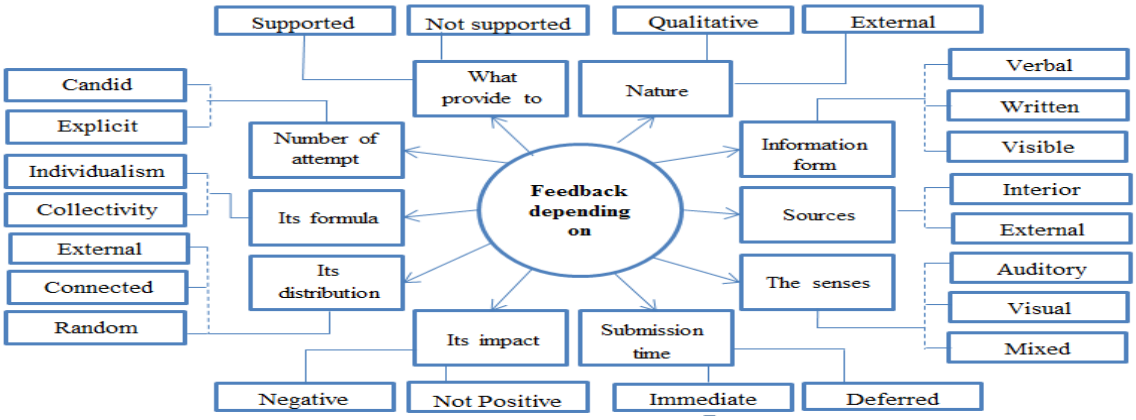

Figure 1: Classifications of feedback types

Studies confirmed that students with a specific learning style may respond more positively to different personally preferred types of feedback, further developing their [52].

FC for GT

The concept of giftedness in the Oasis Enrichment Model is viewed as a composite of the cognitive, personal, and social aptitudes and skills that enable the individual to excel in one or more fields of interest as compared to their peers. This concept is sufficiently flexible and expandable to incorporate the elements that contribute to excellence in a given domain, such as heritable innate abilities (intelligence), cognitive abilities, personal and social traits (including motivation), and the cultural, knowledge-related, and experiential opportunities that an individual may be involved in.

The perceptions and experiences of gifted students and their teachers to better understand how online learning environments can meet the needs of ST. were examined [55], It was found that the online format was conducive to a more individualized and differentiated learning experience than the regular face-to-face setting: "Students can work at a pace consistent with their rate of learning, have more time to reflect, feel more in control of the learning process, and engage in more self-directed and independent learning"

Alternatively, some advantages of flipped classrooms identified as: developing critical and higher-level thinking, collaborative work, schedule flexibility, and ability to review or pause lecture materials when needed. All of this is aligns with what is recommended by talented studies, where talented students need to lead their learning and determine their speed in learning, attention to higher skills, and management of personal knowledge and their experiences [16];[18];[19].

Relationship between LS and TS

Learning styles influence how students respond to classroom performance [3]. Learning styles was assisted in terms of how the learner process absorb, and retain information [56]. And was defined as a set of behaviors defining the individual's preferred and relatively constant method that makes them more efficient and effective in handling information [57].

Talented students tend to be independent and aware of their own needs, feelings, and attributes distinctly from others' [58]. Some studies pointed out that learning styles may not differ between high- and low-achieving students [58]; [59]. Excelling middle school students prefer visual, auditory, verbal, logical, and independent LS, while kinesthetic and interpersonal LS did not have significant influences on scores [60]. Similarly, students using independent, analytical, and systematic LS are more likely to perform better [13].

LS Measurement

Kolb identified four LS: diverging (concrete experience and reflective observation), assimilating (abstract conceptualization and reflective observation), converging (abstract conceptualization and active experimentation), and accommodating (concrete experience and active experimentation) using its LS inventory scores [62]. There is no strong correlation between participants' LS preferences and their achievement scores; the

learning styles showed no association with students' overall achievement [5].

All versions of the LS scale have had the same format: a short questionnaire (nine items for LS, and 12 items for subsequent versions) where respondents to rank four-sentence endings that correspond to the four learning styles.

Importance of PKMS for TS

PKMS are skills that lead enhance cognition, communication, collaboration, creativity, problem-solving, lifelong learning, social networking, and leadership to improve the effectiveness, productivity, and innovation of individuals [63];[64]. The most essential type of skills of information, ideas, and knowledge elements are accessing, evaluating, organizing, analyzing, conveying, collaborating, and securing information and ideas [65]. PKMS improve students' cooperation, collaboration, and connection among similar-interest individuals in data and information processing into knowledge [66]. That is what the talented needs. There is an effective relationship between the utilization of technology and increasing PKMS [67].

These skills are time control; workplace wellness; speedy reading, notation, and research; document structuring; information design; target writing; processing infrastructure; and filtering techniques. Also, a set of strategies to help students manage their PKMS in online courses using web tools: socialization, externalization-, combination, and internalization proposed by [68].

Seven PKM skills were set as: retrieving; evaluating/assessing; organizing; analyzing; presenting; securing; and collaborating. Studies highlight the importance of PKMS in improving individual performance, enhancing individuals' personal, organizational and social environmental effectiveness, and developing abilities' self-awareness [68];[69];[70].

Search Problem

More than 70% of gifted students' teachers responded that their students were not challenged or given a chance to further develop in their classrooms. Talented students need advanced programs in many cases because the regular education program is not yet ready to meet their academic needs [71];[6]. Besides, science-talented students often get bored in passive learning–traditional lectures [23]. Previous studies of FC yielded promising results for various academic outcomes including enhancement of subject-based performance, language acquisition, critical thinking, and information literacy [72]; [73]; [74];[75];[76];[77];[78];[11]. Most interactive videos–based flipped classrooms exhibited effectiveness in developing some skills and increasing cognitive achievement [79]; [80]. Also, research studies indicate that science-talented students have maintained LS preferences that distinguish them from other students [59]. Therefore, a diverse approaches is required to cater to ST.

Students in the 21st Century require soft skills and knowledge, preferably occurring in authentic learning situations and include greater collaboration, communication, problem-solving, and critical thinking [81]. There has been relatively little discussion about using PKMS and tools in the learning process [67]; [68]. Studies highlight the importance of PKMS in improving individual performance and effectiveness in personal, organizational, and social environments and developing self-awareness of their limits and abilities[66];[67] ;[70]; [81].

Currently, literature did not examine how the feedback of IV-based FC instruction with LS influences PKMS and achievement for STS. So, the research problem is determined without considering talented students' LS as one of the important drivers in educational design, besides the need to study some types of feedback appropriate to the proposed designs for developing PKMS and achievement for science-talented students.

Questions

(1) What is the effect of the difference between the (text and auditory) feedback in the IV on the Personal Knowledge Management Skills for science-talented students?
(2) What is the effect of the difference between the (text and auditory) feedback in the IV on the achievement for science-talented students?
(3) What is the effect of the difference between the LS (convergent- divergent) in IV on the Personal Knowledge Management Skills for science-talented students?

(4) What is the effect of the difference between the LS (convergent- divergent) in IV on the achievement of science-talented students?
(5) What is the effect of the interaction between the (text and auditory) feedback in the IV and the LS (convergent- divergent) among science-talented students on Personal Knowledge Management Skills?
(6) What is the effect of the interaction between the (text and auditory) feedback in the IV and the LS (convergent- divergent) among science-talented students on achievement?

Method

- **Research Model:** This study was designed in the exploratory research method.
- **Participants**

The study was conducted on science-talented students in the G8 of middle school from the Hail Gifted Care Center. Students had to pass a measure of mental abilities testing at the KSA level and within the best 5% with an academic level exceeding 90% in their schools.

- **Data Collection Tools**

An objective achievement test in the plant reproduction unit of science, The PKMS Scale, was prepared by Dorothy (2010) and translated by [82]. Assessment of LS was conducted using Kolb's LSI.

Implementation

- **Variables:** The research dealt with three types of variables: independent variables (feedback (audio/ text) with the IV), classification variable (convergent and distant LS), and dependent variable (achievement – PKMS).
- **Design:** This study employed a descriptive-analytical method to analyze previous studies and a quasi-experimental transversal comparison of equivalent groups design to identify the effect of the interaction of independent and taxonomic variables on dependent variables as explained in table 1:

Table (1) Experimental design for research

Experimental	Pre-Test	Treatment	Feedback	Post Test
Group 1	Achievement Test	FC based on IV for divergent	IV – AF	Achievement Test + PKMS scale
Group 2			IV – TF	
Group 3		FC based on IV for converging	IV – AF	
Group 4			IV – TF	

Procedure

- Designing an FC Environment Based on IV:

(Usama, 2018) the model was adopted for the design of the FC based on the IV format (2):

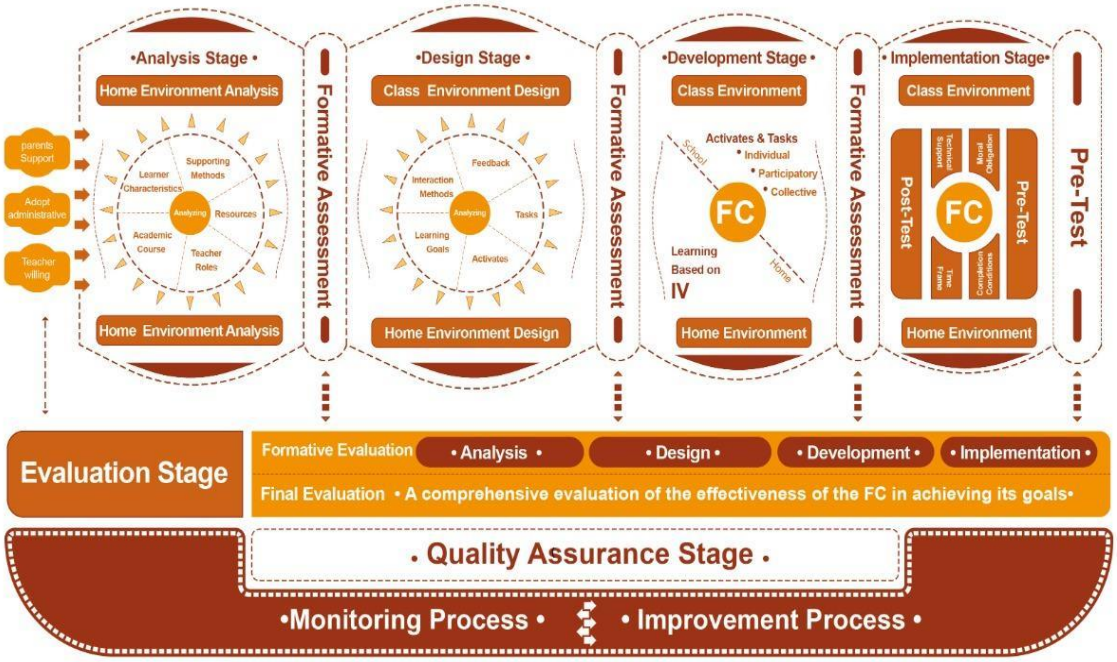

Figure 2: Educational design model for the FC

The analysis stage included the following:

- Problem analysis and needs assessment: The problem was identified as science-talented students' lacking personal skills and their educational needs were the need for a set of skills and knowledge developing their PKMS and achievement.
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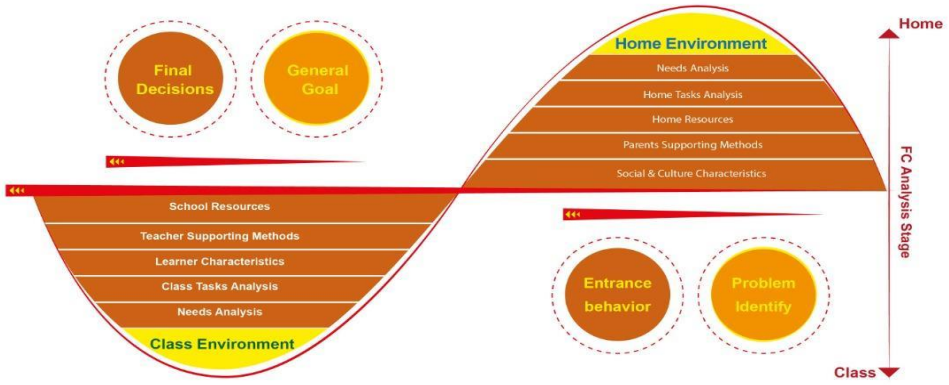

Figure 3: An analysis stage of the FC

First, this step ended with the formulation of the general goal of "Developing PKMS and achievement among STS", in light of the adoption of the list of PKMS [82].

- Analysis of educational tasks: set general objectives and analyze educational tasks branching into sub-procedures in the plant reproduction unit. The form and number of tasks that STS will perform in the classroom and those at home were determined.
- Learners' characteristics analysis: STS in G8 science educational challenges were the lack of PKMS-related information and skills. They were grouped into four experimental groups suited to divergence and convergence learning styles.
- Analysis of resources in the educational environment: The educational resources and resources available to STS, which were used to ensure the presence of a smart device or a computer with each student at home.

2- Second, the design stage: The formulation of the educational program design was planned for the FC, and the stage contained the processes shown in figure 4 as follows:

- Formulating learning objectives: The objectives of the IV–FC were determined in light of a list of 40 goals.
- Organizing the content and following up its presentation: The plant reproductive unit content elements that can achieve the required objectives were identified.
- Defining activities and assignments: The activities and assignments presented in the FC and the IV content were identified by the two types of auditory feedback & text feedback.
- Designing an education strategy: Learner-centered learning strategies were used to stimulate learning by drawing attention and setting goals associated with each skill.
- Determination of evaluation methods (tests and assignments for separation) and feedback methods for e-content (e-tests, e-activities, and assignments).

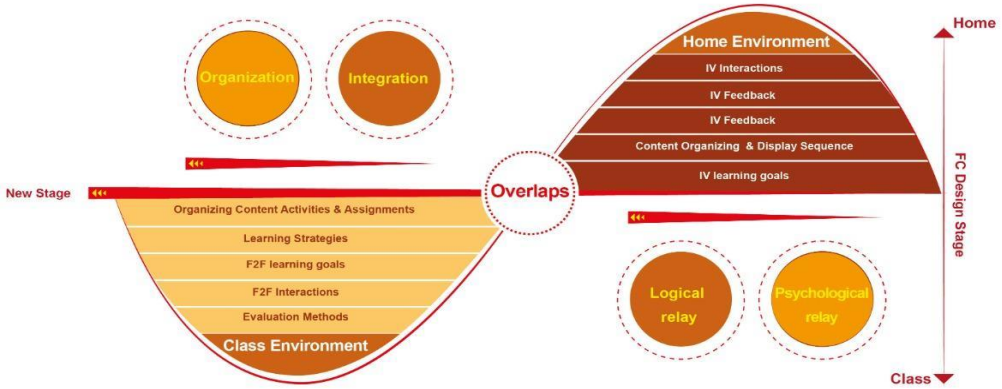

Figure 4: The design stage for the FC

The content was determined to achieve educational goals.

- The process of identifying meeting points

- Defining methods of presenting the content: The most appropriate (traditional/electronic) presentation method was chosen, and the content was reformulated into adaptive activities suiting to STSs' needs and facilitating the transition from face-to-face learning, class, and home learning.
- Feedback: Forms of auditory feedback & text feedback were determined and presented to the learner, whether in the traditional classroom or during the IV.
- Interaction design and communication methods: The forms of interaction were identified (the learner's interaction within the classroom/home environment, the interaction of learners with each other/with the teacher, and the interaction of learners within the IV), and communication methods were identified within the learning environment (e-mail) with an emphasis on the importance of taking into account systemic work.
- Flowchart design: The learner's journey to the targeted learning outcomes were illustrated by streamlined flowcharts showing the arrangement of traditional or e-learning situations, the tribal requirements of each position, and how it relates to what follows or precedes it.

- Third, the development stage: It focused on the formation of multimedia elements presenting the content: traditional and e-texts, pictures, digital sounds, real and virtual samples and forms, fixed and animated graphics, and video clips (figure 5).

In light of production standards, the appropriate production incubation was chosen:

- Production incubation was based on the adoption of e-products (text, images, sounds, and video) and was used as it is.
- Partial Production Incubation for some e-products was modified to suit the product with the needs.
- Total production incubation for some e-products was developed according to the targeted learning needs.

The following IV build was done:

- Scenario Preparation: Per the skill list, behavioral goals, and content, an IV scenario content has been built and set up as follows: After designing the initial scenario, it was presented to specialists' review (goals, scientific terms, presentation and sequencing, the appropriate number of frames for content, appropriate forms of interaction, and feedback display method). Arbitrators confirmed the validity of the scenario for use by approximately 92%, with the amendment of some language versions

and the addition of some illustrative examples. Adjustments were made and the scenario was finalized.

Production of video footage: Videos were recorded via Snagit9. The clips were stored on the computer via the TV card. Then the clips were compressed. The audio was then dubbed on the video. The texts were written using Microsoft Office Word 2010, accounting for the compatibility between font and screen sizes and display area. Adobe Audition CC7.0 CS5 was used for sound production and effects. Output was in mp3, Wav format. Adobe Premiere Pro CC 2016 was used to produce various video elements, whether for IV. Photoshop CC 7.0 Adobe was used for graphics and still images and image adjustments, basic template, and button designs. Output images and graphics were in .jpg, .png formats. Illustrator CC 2015 software was used for producing bitmap and linear images and handling graphics in ai, esp.

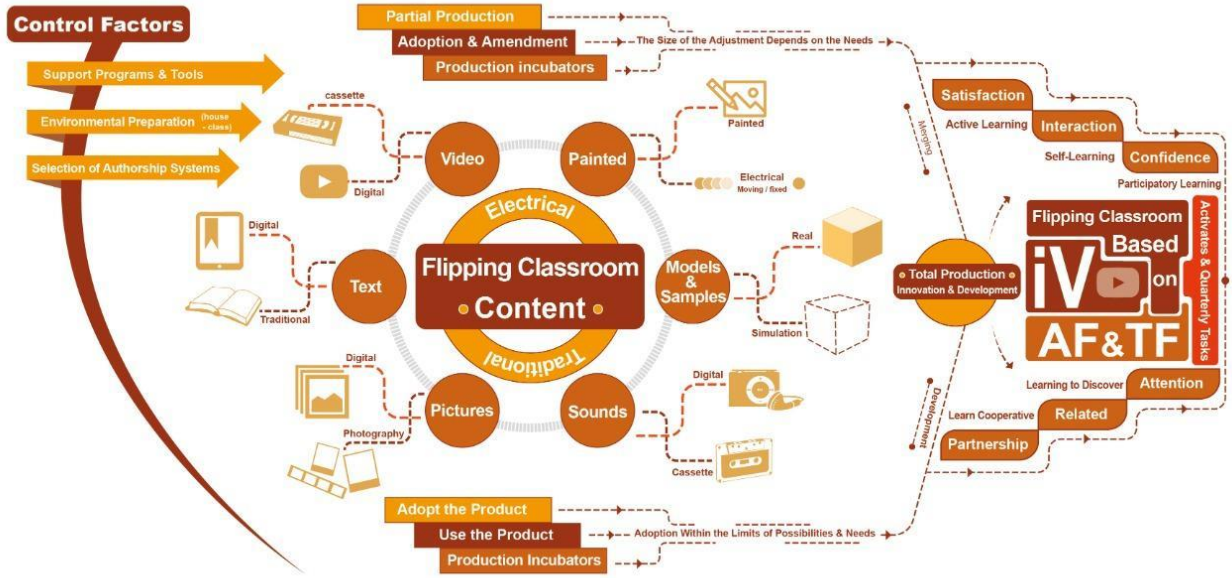

Figure 5: The development stage and the production of the necessary learning objects IV in the FC

After producing the videos and montaging and rendering operations, the videos were uploaded to YouTube. Playposit platform was used to convert the videos into IV, as the interactions were added to each video according to the specific scenario. Finally, we got the IV. Wix was used to build an e-environment to display IVs and manage the learning environment, by using one of the ready-made templates and modifying them to suit learning topics and the needs of outstanding learners. All of that was linked to IV, by defining learning paths for each sample of the four research samples, allowing learner access to the path of his learning only.

At the end of the stage, a back-learning environment based on the IV was produced with two types of feedback (AF and TF), characterized by the following: (Integration and partnership between the components of the content, confidence in the content, multiple interactions between all the elements, product satisfaction, intrigue, diversity, and versatility), while emphasizing the presence of diversity in the learning method (commensurate with the content and place of learning) such as problem-based learning, participatory learning, and self-learning within the IV–FC. It presented during AF or TF, and uploaded to the below link:

https://intervideoedit.wixsite.com/plantreproduction

Fourth, the experiment and evaluation stage: This occurred in two main processes (figure 6):

Formative evaluation: The production stages of the FC were evaluated across all stages of the FC

educational design, providing interim feedback, and the subsequent progressive adjustments to ensure the quality of the outputs of each stage.

The final evaluation: It included the learners' evaluation where a pilot study was conducted on 20 students dealing with an IV–FC environment, assessing the comfort and ease of use and ability to suffice before publication and application.

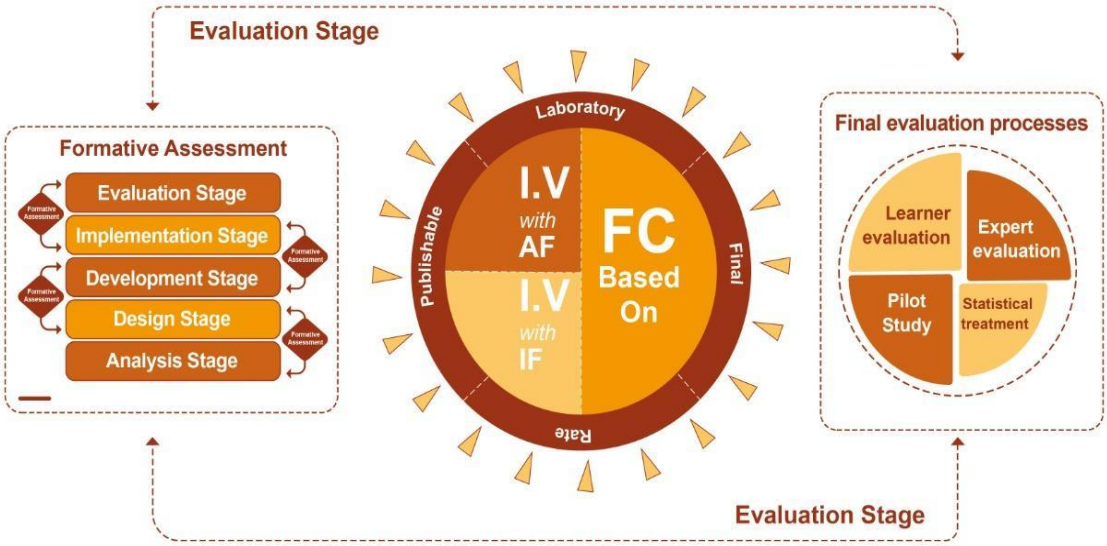

Figure 6: Stage of evaluation and experimental implementation

Expert evaluation: Specialists assessed the learning environment per the adopted technical and educational standards to ensure its sincerity and sufficiency. The average percentage of agreement on the quality of dual-feedback IV–FC environment was 93.6%: a high ratio. Recommendations were setting an icon skipping the introduction, correcting some language errors, and modifying some video clips in terms of size and timing. Afterwards, the FCs were finalized.

Fifth: The Implementation Stage

The interaction with the IV–FC began by applying the LS scale (students were divided into four experimental groups), followed by providing the student with credentials for the learning interface with its two types: AF &TF.

The learning method was explained by IV–FC for the learners with a guide when needed, declaring the terms of achievement. The research team supervised ethical commitment, technical support, and management of the FC throughout the process.

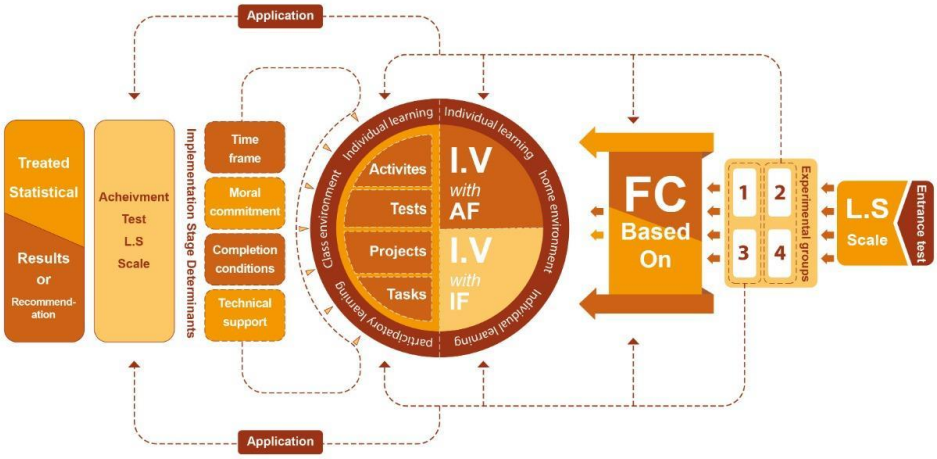

Figure 7: The operations of the implementation confirmation stage

The evaluation stage used measures of PKMS, educational activities, and tasks delivered to students. Maintaining the timeframe for learning per the flexibility guaranteed by the determinants of education in the FC, the experimental treatment was applied within 2–20 November 2019 in cooperation with the Hail Gifted Center.

- Sixth: Quality Assurance Stage

This stage had multiple dimensions: technical, economic, social, and educational dimensions. It also included the first follow-up process (figure 8) including three main metrics: technical support (solving programming problems faced at home), technical educational/academic support (provided to learners f2f), and continuous review (periodic reviews to improve performance and maximize strengths to ensure the quality of learning).

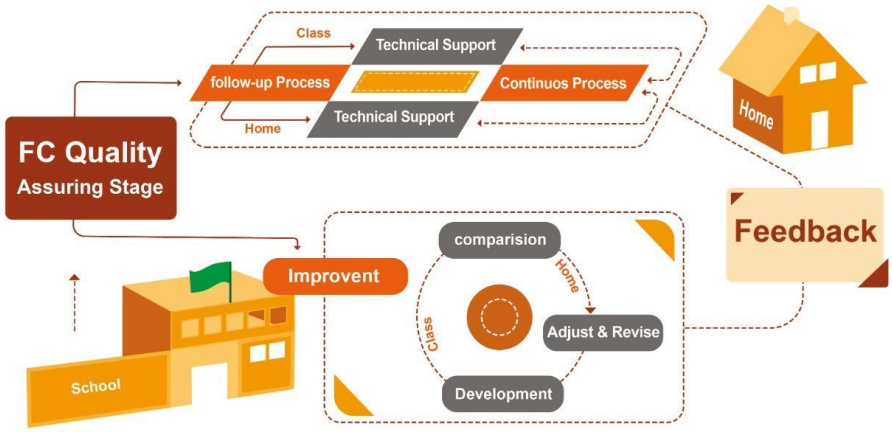

Figure 8: Quality Assurance Stage

Second: The improvement process: It included three main procedures: comparison with similar educational products to identifying them and the extent of their implementation of educational requirements, control and revision (a comprehensive review of the scientific content and production programs), and the continuous development of the FC whether partial or radical.

Findings

Limitations

First, the participants were few from different schools (due to the small population of gifted and talented students) , limiting the

generalization of this study. Second, this study tried to study interaction with only some learning styles and feedback type on IV–FC, achievement, and PKMS. Third, the research was limited to a single science topic: plant reproduction. Fourth, the research omitted talented students with convergent and divergent LSs due to a lack of them in the Gifted Center in Hail. The effects of gender, IQ, digital skills, and previous experiences, especially in [4], findings, stress the importance of these variables

Implications

A one-size-fits-all educational model does not work for today's talented classroom. We should create an interactive e-learning environment to encourage different talented students and their learning styles to express and exchange their thoughts and ideas and collaboratively solve problems.

Results

- **To answer Q1**, an independent sample t-test was used to test the difference between the TF and AF in the IV–FC on the PKMS for STS, as the following in table (2):

- Table 2: Results of the difference between the TF/AF in the IV–FC on PKMS for STS

PKMS	LS	N	Mean	Std. Deviation	T	df	Sig
Access	TF	25	43.44	2.70	1.59	48	0.120
	AF	25	44.64	2.64			Not Sig.
Evaluating	TF	25	37.48	3.73	0.92	48	0.362
	AF	25	39.20	8.55			Not sig.
Organizing	TF	25	41.48	4.06	1.15	48	0.255
	AF	25	42.60	2.67			Not Sig.
Analysis	TF	25	43.76	2.91	1.68	48	0.100
	AF	25	42.60	1.84			Not sig.
Conveying	TF	25	42.40	3.02	0.74	48	0.466
	AF	25	43.00	2.73			Not Sig.
Sharing	TF	25	38.48	4.11	0.86	48	0.393
	AF	25	39.48	4.09			Not sig
Providing	TF	25	41.20	3.10	0.30	48	0.763
	AF	25	41.48	3.41			Not sig.
Total	TF	25	288.24	10.21	1.79	48	0.079
	AF	25	293.00	8.47			Not sig

The results (table 2 and figure 9) revealed the lack of statistical differences between the TF and AF, in terms of (Access to, Evaluating, Organizing, Analysis, Conveying, Share, and Providing) processing ideas and information skills of IV on the PKMS, as well as the absence of statistical differences between the TF and AF in the total score of the IV–FC on the PKMS.

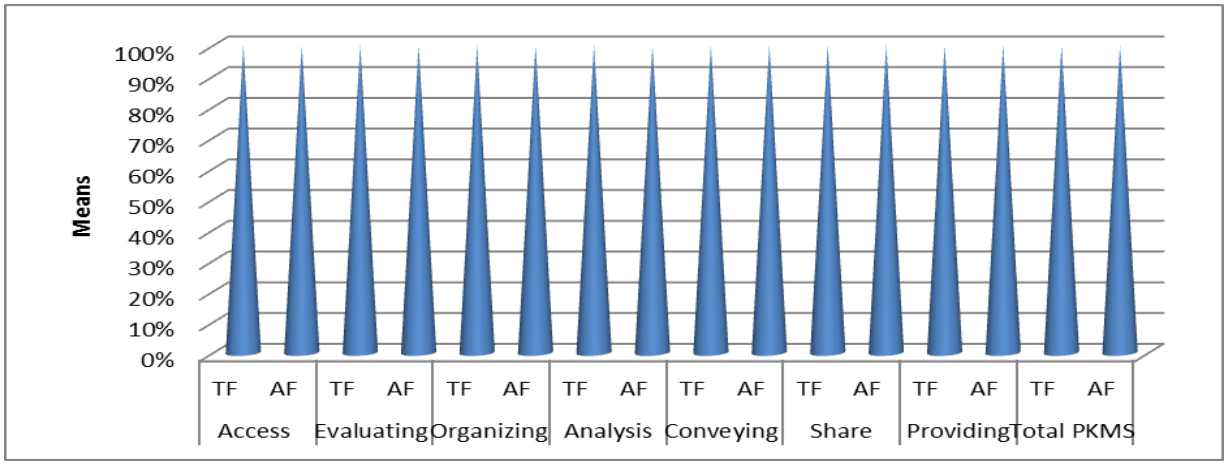

Figure 9: Difference between means of the PKMS Skills for the TF/AF in IV–FC

- **To answer Q2**, an independent sample t-test was used to test the statistical difference between the TF/AF in the IV–FC on the achievement for STS as in table (3):

- Table 3: The results of the difference between TF/AF in IV–FC on STS

Feedback in IV	N	Mean	Std. Deviation	T	df	Sig
TF	26	36.0769	1.95802	0.42	50	0.668
AF	26	35.4231	7.47354			Not sig.

-

- The results (from Table 3& Fig 10) showed the lack of statistical differences between the TF and AF in IV on the achievement for STS. Although the average of TF is higher than AF

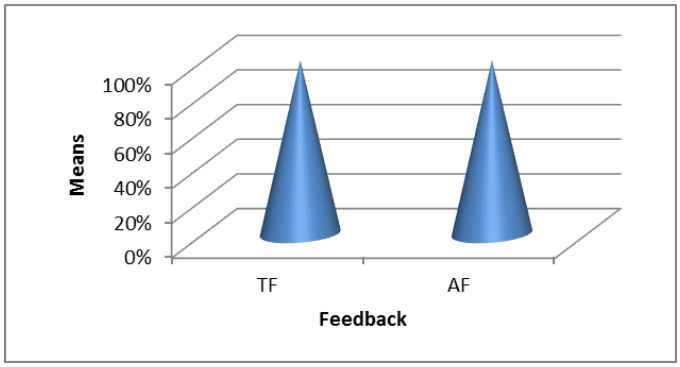

Figure 10: Difference between means of the achievement for the TF/AF in IV–FC

From the results for Q1& Q2, although there is a clear improvement of PKMS and achievement induced by IV–FC, there are no evident differences between TF and AT.

- **To answer Q3**, independent samples t-test had been used to test the differences between the convergent and distant learning styles in IV–FC on PKMS for STS as in table (4):

-

- Table 4: Results of the difference between convergent/distant learning styles in IV–FC on PKMS for STS

PKMS	LS	N	Mean	Std. Deviation	t	Df	Sig
Access	Divergence	24	42.87	3.12	3.17	48	0.003
	Convergence	26	45.11	1.72			**Sig**.
Evaluating	Divergence	24	37.71	8.40	0.65	48	0.521
	Convergence	26	38.92	4.40			Not sig.
Organizing	Divergence	24	40.45	3.83	3.44	48	0.001
	Convergence	26	43.50	2.28			**Sig**.
Analysis	Divergence	24	43.71	2.29	1.46	48	0.151
	Convergence	26	42.69	2.60			Not sig.
Conveying	Divergence	24	43.75	2.64	2.63	48	0.011
	Convergence	26	41.73	2.77			**Sig**.
Sharing	Divergence	24	39.08	3.39	0.17	48	0.866
	Convergence	26	38.88	4.71			Not sig
Providing	Divergence	24	40.62	2.61	1.52	48	0.135
	Convergence	26	42	3.64			Not sig.
Total PKMS	Divergence	24	288.20	10.80	1.74	48	0.088
	Convergence	26	292.84	7.88			Not sig

- There were statistical differences between the learning styles in the access and organizing aspects of ideas and information skills of IV–FC on PKMS for STS for the convergence

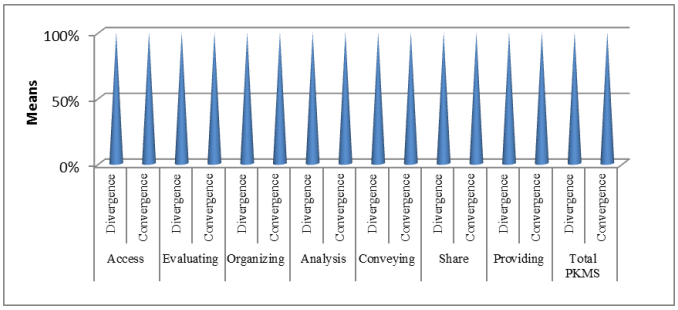

Figure 11: Difference between means of the PKMS efficiencies for the learning styles

Statistics remained marginally similar in the rest of PKMS across the learning styles. Also, this remained the same when using IV–FC.

- **To answer Q4**, an independent sample t-test was used to test the statistical differences between LS in IV–FC on achievement of STS, as in table 5 and figure 12:

Table 5: Results of difference between the LS (convergent- distant) in IV–FC on achievement of STS

LS	N	Mean	Std. Deviation	T	Df	Sig
Divergence	26	34.42	7.27	-1.80	50	0.007 **sig**
Convergence	26	37.08	1.83			

There were statistical differences between learning styles in IV–FC on students' achievement in favor of convergence; the average of convergence exceeded that of divergence's

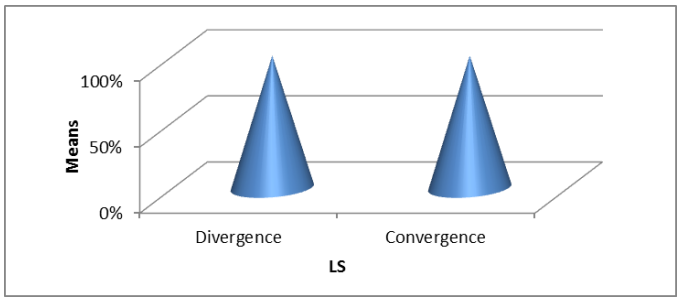

Figure 12: Difference between means of achievement for learning styles

- **To answer Q5**, a two-way ANOVA was used to test the TF–AF interaction in the IV and learning styles and its effect on PKMS. Each of the seventh PKMS was treated separately with varying degrees:

*For access to ideas and information skills***,** the data were analyzed as shown in table 6: there was no statistical TF–AF interaction in IV–FC and the learning style influencing the access to ideas and information skill.

Table 6: Interaction between TF–AF in IV–FC & learning styles among students' access to ideas and information skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	93.36	3	31.12	5.33	.003
method * LS	12.72	1	12.72	2.17	.147
Error	268.55	46	5.83		
Total	97338	50			
Corrected Total	361.92	49			

*For evaluating ideas and information skill***,** the data were analyzed as in table 7: there was no statistical interaction between TF–AF in IV–FC and LS influencing evaluating ideas and information skill.

Table 7: Interaction between TF and AF in IV–FC and learning styles evaluating ideas and information skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	111.07	3	37.02	.84	.477
Intercept	73287.21	1	73287.21	1670.44	.000
method * LS	55.67	1	55.67	1.26	.266
Error	2018.14	46	43.87		
Total	75627	50			
Corrected Total	2129.22	49			

For organizing ideas and information skill, table 8 shows data analysis: there were statistical

interactions between TF–AF in the IV–FC and learning styles influencing the organizing ideas and information skill.

Table 8: Interaction between TF and AF in IV–FC's and LS on STS organizing ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	312.38	3	104.12	17.64	.000
Intercept	87971.54	1	87971.54	14903.18	.000
Feedback * LS	181.24	1	181.24	30.70	.000
Error	271.53	46	5.90		
Total	88952	50			
Corrected Total	583.92	49			

To determine the mean differences between the four groups, we performed the post hoc analysis using the Tukey test as following (table 9 &figure 12):

Table 9: Tukey test results for the TF–AF interaction in IV–FC and LS on students' organizing ideas and information skill

Skill	Feedback in IV	LS	Mean	Std. Error
Organizing	Text	Divergence	37.917	.701
		Convergence	44.769	.674
	Audio	Divergence	43.000	.701
		Convergence	42.231	.674

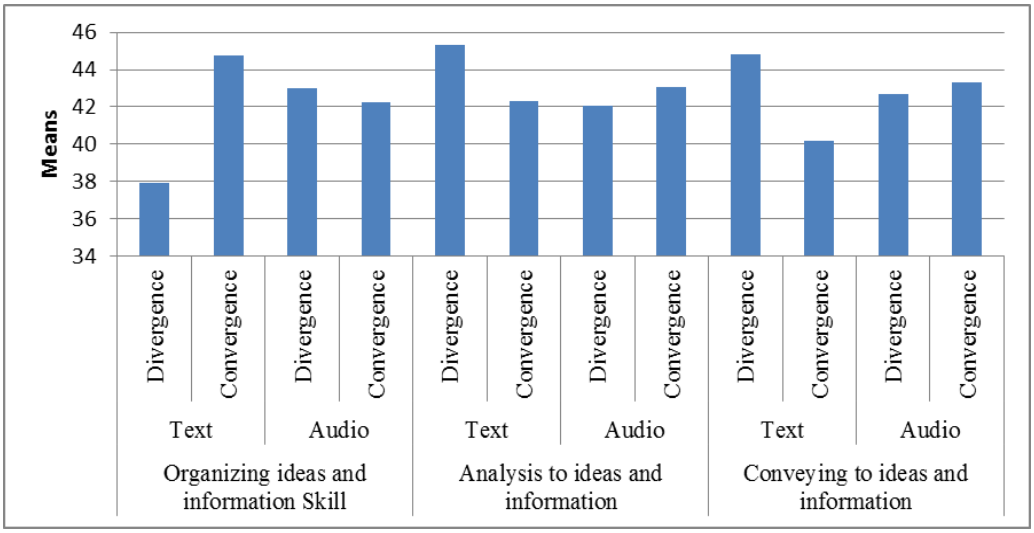

Figure 12: interactions' results between TF–AF in IV–FC and learning styles on students' organizing, analysis, convergence of ideas and information skills

For analysis of ideas and information skill, the data analysis is in table 10; there were statistical interaction effects between the TF and AF in IV-FC and LS influencing analysis of ideas and information skill.

Table 10: interaction results between TF–AF in IV-FC and learning styles on students' analysis of ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	80.10	3	26.70	5.50	.003
Intercept	93164.08	1	93164.08	19193.97	.000
method * LS	50.40	1	50.40	10.38	.002
Error	223.27	46	4.85		
Total	93529	50			
Corrected Total	303.38	49			

To determine the mean differences between the four groups we performed the post hoc analysis using the Tukey test, as in (Fig 12 & table 11).

Table (11) Tukey test results for the (TF- AF) in IV- FC and

LS (convergent and **divergent**) among STS on Analysis ideas & information skill

Skill	Method	LS	Mean	Std. Error
Analysis of ideas and information	TF	Divergence	45.33	.636
		Convergence	42.30	.611
	AF	Divergence	42.08	.636
		Convergence	43.07	.611

*For conveying ideas and information skill***,** table 12 shows data analysis; there were statistical interaction between TF and AF in IV–FC and learning styles affecting the analysis of ideas and information skill.

Table 12: Interaction between TF–AF in IV–FC and learning styles on students' conveying ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	143.70	3	47.90	8.44	.000
Intercept	91190.88	1	91190.88	16084.59	.000
method * LS	88.32	1	88.32	15.57	.000
Error	260.79	46	5.66		
Total	91569	50			
Corrected Total	404.50	49			

To determine the mean differences between the four groups, we performed the post hoc analysis using the Tukey test (as in table 13):

Table 13: Tukey test results for the TF and AF in IV–FC and Learning styles on students' conveying ideas and information skill

Skill	Method	LS	Mean	Std. Error
Conveying Ideas and Information	Text	Divergence	44.83	.687
		Convergence	40.15	.660
	Audio	Divergence	42.66	.687
		Convergence	43.30	.660

For sharing ideas and information skill, table 14 shows data analysis; there were no statistical interaction effects between TF and AF in IV–FC and LS influencing sharing ideas and information skill

Table 14: Interaction between TF–AF in IV–FC and learning styles on students' sharing ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	15.87	3	5.29	.302	.823
Intercept	75865.93	1	75865.93	4334.64	.000
Method * style	2.88	1	2.88	.16	.687
Error	805.10	46	17.50		
Total	76793	50			
Corrected Total	820.98	49			

For providing ideas and information skill, table 15 shows data analysis; there were no statistical interaction effects between TF and AF in IV–FC and learning styles providing ideas and information skill.

Table 15: interaction between TF–AF in IV–FC and learning styles on students' providing ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	30.17	3	10.05	.95	.421
Intercept	85199.59	1	85199.59	8113.49	.000
Method * style	5.60	1	5.60	.53	.469
Error	483.04	46	10.50		
Total	85963	50			
Corrected Total	513.22	49			

For total PKMS, table 16 shows data analysis; there were no statistical interaction effects between TF and AF in IV–FC and learning styles influencing the total PKMS

Table 16: interaction between TF–AF in IV–FC and learning styles on students' providing ideas and information skill

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	567.09	3	189.03	2.20	.100
Intercept	4213551.47	1	4213551.47	49160.23	.000
Method * style	15.43	1	15.43	.18	.673
Error	3942.68	46	85.71		
Total	4227509	50			
Corrected Total	4509.78	49			

- **To answer Q6**, a two-way ANOVA was used to test the interaction as in table 16:

Table 16: Interaction between TF–AF in IV–FC and learning styles on students' achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	143.28	3	47.76	1.69	.181
Intercept	66459.25	1	66459.25	2355.212	.000
Feedback	5.56	1	5.56	.197	.659
LS	91.55	1	91.56	3.25	.007
Feedback * LS	46.17	1	46.17	1.64	.207
Error	1354.46	48	28.22		
Total	67957	52			
Corrected Total	1497.750	51			

There was no interaction between TF and AF in IV-FC and the learning style on students' achievement.

Discussion

The results revealed that in IV–FC, there were no statistical differences between TF and AF concerning achievement or skills, though TF's averages exceeded those of AF. However, there was a clear improvement in skills and achievement. Also, there were no statistical differences between learning styles (convergent- distant) on students' skills and achievement in flipped classes. There were no statistical interaction effects between TF and AF in IV–FC and LS influencing skills and achievement, though there are some interaction effects in some skills (conveying, analysis, and organizing).

We attribute this to the retention-supportive role of interactive videos. Previous studies agree that IV guides the learner's attention and motivation increases achievement, knowledge, and formative assessment [42]; [48]; [65]; [86]. Also, the findings agree with [11]; [19]; [36]; [79]; [80]; [87]. That IV would improve problem-solving, communication, and reasoning. And it was seen that FC facilitates motivation, autonomy, and commitment [14]; [42]. However, FC and IV are irrelevant to achievement, skills, and performance [62]. Same for which confirmed that the LS affects different levels of performance and achievement [88]. Interactive elements are designed to allow the user to reflect on the information delivered before moving to the next step in the learning process [89]. So, interactive components ensured that the learner comprehended the content instead of simply viewing it. Also, research showed that interactive videos are a powerful tool in education encouraging reflection and student-directed learning [90]; [91]. Hence, science-talented students are encouraged by the use of these IV–FC where most of them maintained high performance. The environment they operated within seems irrelevant to their will to consistently achieve and complete assignments regardless of the challenge [3]; [6].

Interpretation in the Light of Learning Theories

This concept of FC is a combination of behaviorist principles and constructivist ideology. Unlike constructivism, behaviorism focuses places the teacher as the center of instruction and content includes tutorials, lectures, demonstrations, and other teacher-focused instruction. The classroom was conducted as so.

Alternatively, constructivism is based on the principle that an individual uses prior knowledge and experience to build and understand new concepts; individuals possess the information and they try to unravel this information [23].

Accordingly, knowledge was constructed or reconstructed by students when they utilized interactive videos. This construction and reconstruction were done via active learning strategies such as problem-based learning. Through interactive videos, knowledge construction occurred. Students are comprehending content at a higher level rather than memorizing it, as the latter contributes to the problem.

Sociocultural conflict theory is also relevant to the FC–learning approach, suggesting that discrepancy or conflict sparks cognitive development. Socio-cognitive conflict theory identifies conflict as an essential ingredient to induce cognitive change [18], which occurred during the use of the problem-solving method in F2F learning or during the implementation of assignments and activities in IV.

Conclusion and Suggestions

In general, IV–FC, according to results, showed no TF–AF statistical differences in the achievement or skills of students. Also. there were no statistical differences between learning styles (convergent and distant) on student's skills or achievement, same for TF–AF interaction and learning style. Though some interaction effects were noticed in some PKMS (conveying, analyzing, and organizing.

IV-based FC provides deep learning for STS; IV raises the learner's motivation and attracts his attention, putting STS in continuous interaction with the program with the possibility of providing feedback. Availing gifted learners with appropriate choices for the accelerated course in their area of talent in this type of blended-learning model can help them fulfill their potential for achievement and PKMS.

Contributors reported that the majority of their students described knowledge of their LS as a helpful tool. It improved perceptions of their abilities and empowered them to strive beyond what they had previously accomplished. When students understand how they learn best, they inevitably adjust conditions and devise strategies for facilitating their progress [92]. The integration between the IV and the materials presented during it ideally provided the educational tasks that provide information and skills through real-life situations, same for learner's control, feedback type, and the frequency of the training affecting the mastery of educational tasks. Also, the value of feedback and its importance enhanced students' learning and raised awareness of the strengths and weaknesses of their learning, and that the quality of the feedback provided through IV had an immediate impact on PKMS.

Future research could address the diminishing motivation occurring with the IV-based FC setting. Specifically, how to design IV-based FC with kinds of feedback that could encourage students to develop KPMS and deepen their understanding of topics. This study can be replicated with a large sample size besides including female students and other learning styles. However, the strength of this study lies in its examination of the interaction with learning styles and feedback type on IV–FC and achievement and PKMS, allowing us to explore the interaction effects. Future studies need to unravel the differential effects of matched and mismatched learning styles and kind of feedback in IV to project educational success and gained skills. We must put more effort into researching what kind of e-environments will stimulate talented students' interests and learning needs. Also, further research can be conducted about supporting the flipped classroom method with different gamification practices and teaching approaches or what kind of technology is more suitable for improving talented PKMS.

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