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Persona/scenario (P/S) toolkit enhancing inclusive fashion design education



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Abstract

This study aimed to address the diversity issue in fashion design education by developing two prototypes for Inclusive Fashion Design (IFD) education. The prototypes were constructed based on the 3C3R model of Project-Based Learning (PBL) and incorporated the Persona/Scenario (P/S) toolkit for IFD. Additionally, the study examined the effectiveness of the FEA (Function, Expressive, and Aesthetics) self-checklist and the P/S toolkit in the IFD process. The experiments involved two design instructors, two teaching assistants, and 12 senior-level students divided into four teams. Thematic analysis was conducted on the interview data collected from the participants. The results revealed that FEA factors were highly considered in both education prototypes, regardless of the presence of the P/S toolkit. Maintaining consistency of the IFD concept throughout each stage of the process was found to be crucial, and the use of the P/S toolkit played a significant role in achieving this consistency. Team communication emerged as an essential factor in IFD education, as team collaboration using the P/S toolkit triggered diverse perspectives on targets, facilitated design expansion, and extended individual competences. Overall, this study contributes to the understanding of the diversity issue in fashion design education and promotes the adoption of the IFD education methodology, emphasizing the significance of consistent concept development, effective toolkits, and team collaboration in achieving inclusive design practices.

Keywords: Inclusive fashion design, Fashion design education, Persona/Scenario toolkit, 3C3R, FEA

Introduction

In the current era, where there is a shift towards individual values rather than a collective culture that emphasizes homogeneity, diversity has emerged as a crucial issue. Scholars argue that integrating diversity into education is an essential initial step towards achieving broader social inclusion (Tienda, 2013). As society embraces diversity instead of uniformity, and the fashion industry follows this trend, it is imperative to systematically study specific methods and processes of inclusive fashion design and develop educational programs to support it. Existing literature primarily focuses on case analyses, design methodologies, and conceptual models that incorporate inclusion principles (Lee & Cassim, 2009; Slesarchuk et al, 2019; Waller et al., 2015). These studies aim



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to enhance marketability within the industry or develop frameworks tailored to specific stages of the design process. When it comes to inclusive design processes in education, the emphasis is on engaging learners through empirical methodologies and addressing the specific needs of target groups, such as individuals with disabilities or plus-size individuals (Altay et al., 2016; Falcão & Simões-Borgiani, 2016; Hudson & Hwang, 2022). However, inclusive fashion design requires research that explores the physical and emotional aspects of various adaptable objects, rather than solely focusing on specific features. Furthermore, there is a scarcity of studies that systematically explore the inclusive design process from a pedagogical perspective.

To promote the wider adoption of inclusive fashion brands and designs, it is crucial to develop design guidelines based on the inclusive fashion design methodology and conduct comprehensive research on educational adaptation. Therefore, the objective of this study is to create an education prototype for inclusive fashion design using a user research tool (Persona/Scenario toolkit) and a virtual fitting software (CLO). Furthermore, the study aims to systematize the inclusive fashion design process and methodology and gain educational insights by evaluating the effects of the inclusive fashion design education prototype and the Persona/Scenario toolkit from multiple perspectives (learners and educators). By contributing to the systematization of the inclusive fashion design methodology, this study will facilitate the advancement of inclusive fashion design research and the standardization of practical inclusive fashion design education.

Literature Review

Inclusive design

The definition of inclusive design according to the British Standards Institution (2005) is 'creating mainstream products and services that can be accessed and used by as many individuals as reasonably feasible, without requiring any specialized design or adaptations.' Inclusive design is a concept that is used similarly to universal design and refers to a more comprehensive 'design for all' meaning, including spaces and services. Although the goal is not necessarily to attain a solution that caters to everyone universally, the intention is to be practical by creating generic design solutions that meet the particular requirements of various users (Pattison & Stedmon, 2006). Recently, the concept of inclusive design has begun to be applied more extensively in the fashion industry. Some fashion brands, such as Tommy Hilfiger, Chromat, Alexander McQueen, ASOS, and Nike, have launched inclusive fashion design collections. However, among the many terms that refer to user diversity, research that applies the concept of inclusive design (Huh, 2015), which can embrace everyone regardless of physical disabilities, age, etc., is mainly limited to the fields of product design and architectural design (Afacan & Demirkan., 2010; Carse et al., 2010; Marshall et al., 2016; Pattison & Stedmon, 2006), and in the case of fashion design, it is mainly discussed from the perspective of universal design. Inclusive design, as one of the many user-centered design approaches, has the potential to help students appreciate user capabilities, needs, and expectations, a first step towards user-led innovation (Dong, 2010).

Inclusive fashion design (IFD) & IFD process

Inclusive fashion design is an emerging issue, there is currently a lack of substantial discussion on fashion design education and design methods that encompass diversity of users. To address this issue, it is necessary to research a design process that considers the range and characteristics of various target users from the perspective of inclusive fashion and can be linked to the design direction.

The fashion design process has been described as a linear process, such as inspiration, research, and design development (Burns et al., 2016; Dieffenbacher, 2020; Feng, 2020; McKelvey & Munslow, 2011; Stecker, 1996). Periodic and repetitive interconnection between ideas, concepts, and design was emphasized in the general fashion design process. Comparing the processes of general fashion design and inclusive design there were the differences in steps. Hudson and Hwang (2022) proposed four sequential steps for inclusive fashion design: the problem identification, the preliminary ideas and design refinement, the prototype development, and the evaluation, including 3D virtual fitting and prototype assessment. Likewise, Clarkson et al. (2011) divided the four main phases of inclusive design: explore, create, evaluate, and manage. Comparing with the fashion design process (Waller et al., 2015), inclusive fashion design process includes a cycle of core activities that allows them to understand user needs better and emphasizes the evaluation's significance in the inclusive design process. Needs analysis and evaluation phased in the early design process were the significant features of inclusive fashion design process.

The FEA process model (Lamb & Kallal, 1992) has been an effective approach for achieving a balance between functionality and aesthetics in the fashion design process. It has been employed as a problem-solving tool to target users with special needs, emphasizing functional, expressive, and aesthetic aspects (Romeo & Lee, 2015; Stokes & Black, 2012). In their work, Lee et al. (2023) proposed a modified IFD process integrated with the FEA process model, which systematically considers various physical, social, environmental, situational, and psychological aspects of users during the design ideation stage. They suggested using a checklist based on the FEA model within the IFD process to comprehend user needs in the initial design stage, while also introducing the concept of inclusive design and user characteristics.

Persona and scenario (P/S) method

As a user research method, Persona method is commonly used to gain empathy or understanding of user behaviors and needs by gathering user data and constructing a single persona that embodies key characteristics of the target user group (Cooper, 1999). During the process of creating a persona, modeling of personal traits and preferences beyond demographic information occurs, resulting in the creation of a 'virtual prototype of actual users' (Pruitt & Adlin, 2010). Persona method is often accompanied by Scenario method which has a narrative to create a realistic character and provide a compelling story about the persona's needs (Onel et al., 2018).

Regarding inclusive design aspect, the co-creation of persona scenarios gave deeper insight into the lived experience of people with particular disabilities and health conditions (Fuglerud et al., 2020). Designing personas foster understanding when designing

for "unknown users" who have physical differences, such as the elderly, disabled individuals, pregnant women, and others who have not been previously understood empirically (Lee, 2021). Bennett and Rosner (2019) referred to personas and simulations as empathy exercises to promote understanding of users with disabilities. Microsoft's Inclusive Design Toolkit (https://inclusive.microsoft.design) and Cambridge's Personas for examining Digital Exclusion (http://www.inclusivedesigntoolkit.com/digitalpersonas/) show specific uses of this persona-based design. However, Persona and Scenario method rarely used in the fashion design process. Therefore, this study adopted Persona and Scenario method to develop the inclusive fashion design education model and developed the P/S (Persona/scenario) toolkit.

PBL & 3C3R

Problem-Based Learning (PBL) (Woods, 1994) is a learner-focused teaching method that promotes practical problem-solving activities. It emerged as a response to knowledge growth, curriculum fragmentation, and the need for critical thinking skills (Savery & Duffy, 1995). PBL has proven to be more effective than traditional teaching methods in promoting active learning and critical thinking (Gallagher & Stepien, 1996; Hung et al., 2003; Norman & Schmidt, 1992). Successful PBL implementation requires well-designed problems (Lee, 1999; Trafton & Midgett, 2001), with instructors playing a supportive facilitator role and evaluating learning outcomes.

Hung (2006) introduced the 3C3R Problem Design Model to enhance PBL features and address implementation issues. The model includes core components (content, context, and connection) that contextualize PBL content and create a conceptual framework. The processing components (researching, reasoning, and reflecting) are linked to learners' cognitive processes and problem-solving abilities (Hung, 2006). The 3C3R model enables systematic problem design and evaluation of relevance and effectiveness (Tawfik et al., 2013).

This study used a 3C3R model to guide PBL problem and curriculum design.

Methods

The purpose of this study was to develop the education prototype of IFD and an assistive research toolkit. The entire process of this study consisted of four steps (Fig. 1); developing education prototypes and a P/S toolkit, experiments of IFD education prototypes, analysis on the IFD education prototypes, and deducing educational insights on IFD education (Table 1).





	Clarkson et al. (2011)	Hudson & Hwang (2022)	Lee et al. (2023)
Research	Discover	Problem identification	Problem identification Needs analysis
Concept development	Understanding	Preliminary ideas	Preliminary ideas Preliminary design
Design	Translate	Design refinement	Design refinement
Prototype development	Create	Prototype development	Prototype development Implementation
Finalization	Evaluation	Evaluation	Evaluation

Table 1 The IFD processes of precedent studies

Developing the IFD education prototype

This study has adopted the frame of IFD process from the precedent study (Lee et al., 2023) and organized the IFD education prototype into eight steps comparing the 3C3R model. The IFD education prototype was considered the balance of the processing components of 3C3R model (researching, reasoning, and reflecting). Therefore, the first session consisted of researching-reasoning flow both ways and researching-reflecting flow both ways. The second session was mainly focused on the reasoning-reflecting flow both ways. Afterward, the IFD education prototype was manipulated into two types: one offered a P/S toolkit, while the other used conventional target setting method (age, job, lifestyle, T.P.O. and trend information). Table 2 shows the structures of each IFD education prototype.

Developing a P/S toolkit

This study developed a P/S toolkit for IFD education by organizing the characteristics and scope of the target user and linking them with the design direction. The toolkit was based on Microsoft's inclusive design toolkit (https://inclusive.microsoft.design) and Personas for examining Digital Exclusion provided by Cambridge University (http://www.inclusivedesigntoolkit.com/digitalpersonas). The persona spectrums of Microsoft were focused on the physical diversity of persona; the types of disability, temporary and situational impairments. On the contrary, not to limit the IFD education in a functional approach in fashion, this study considered the persona spectrum with a multi-perspective. Therefore, this study developed the items of physical, social, emotional, environmental diversity of persona spectrum.

The P/S toolkit for IFD education consisted of three parts: The P/S toolkit card, the Overview of P/S Set, and the P/S section. The toolkit focused on physical, social, environmental, situational, and psychological aspects, encompassing representations of disabilities, body types, social contexts, and various environmental and situational factors. It also considered the user's psychological needs and values related to identity, sociality, practicality, personality, taste, and trends. The Overview of P/S Set addressed personal information, lifestyle, values, goals, uncomfortable daily situations, and desired elements, while the P/S section created specific scenarios to enhance empathy and immersion. During the writing a scenario based on the features and needs of persona in the P/S section, participants could make the details of users' needs like a real and establish more

Session	Components	Туре А		Туре В		Materials	
	of 3C3R	Steps	Time (min)	Steps	Time (min)		
First session	None	Orientation, team build up, ice breaking	20	Orientation, team build up, ice breaking	20	Lecture, short film	
	Research- ing–Reasoning (Content)	Deriving a problem, finding a way of problem solving	100	Deriving a problem, finding a way of problem solving	100	Design brief, users' body type information	
		Persona/sce- nario toolkit	45	Conventional target setting	45	Toolkit, laptop, internet data search	
	Research- ing–Reflecting (Context)	FEA evalua- tion/interview	15	FEA evalua- tion/interview	15	Self-checklist	
Second session	Reasoning– Reflecting (Connection/	Concept mak- ing	45	Concept mak- ing	45	Pencil & paper, laptop, internet data search	
	Context)	Design sketch	60	Design sketch	60	Pencil & paper, laptop, internet data search	
		Implemen- tation (3D rendering)	60	Implemen- tation (3D rendering)	60	CLO software, laptop	
		FEA evalua- tion/education prototype evaluation/ interview	15	FEA evalua- tion education prototype evaluation/ interview	15	Self-checklist, evaluation form	
		Total	360	Total	360		

Table 2 The structures of each education prototype

segmented design concept. The P/S section also supported the participants promptly to write an idea note to concrete the fashion design. Figure 2 shows the P/S toolkit of this study.

Experiments of the IFD education prototype

After creating two types of IFD education prototype and a P/S toolkit, the main experiments were conducted with a team consisting of two design instructors and two teaching. The experiments involved 12 senior-level students who were randomly divided into four teams. Each team was further divided into two groups, with two teams using a P/S toolkit (Type A) and the other two using a conventional target setting method based on fashion trends and reference analysis (Type B). The task for all teams was to design women's wear for individuals in their 20 s to 30 s with various body types.

To create an immersive atmosphere, the instructor presented a short film on inclusive design and diverse consumers to all teams before the experiment. During the design process, all participants completed the self-check list of FEA based on the precedent studies (Lamb & Kallal, 1992; Lee et al., 2023; Romeo & Lee, 2015) to check reflecting the inclusive concept and maintaining the FEA perspective (Table 3). The participants marked the list into a tri-level; O (definitely considered), Δ (considered a little), X (unconsidered).

Categories	Types				Persona	Persona Physical			Range of	Desire for	
						Information	condition			activity	aesthetics
			Physical Divers	ity		Name: Woojoo	Pregnant almost	Change of	body	House, Office,	Professional and
		•	<u>.</u> U			Age 28/ Female	due	shape and		Hospital	chic image
			61]	ה ו מ		Office worker		weight gai	n		
		·П.	•111	11 /		Seoul		because of	F		
		11				10 Hobbies		pregnancy			
	×	1	v ,	/ /	√						
Physical			Body Type			value			Pain po	int	
Aspect						Things pursued in	life, hopes and goals,	lifestyle,	Uncomt	fortable situations a	nd factors, physica
	1 4	1 4	11	111	A A	patterns and beha	viors	uay uvung	disabilit	y factors, constraint	s on activities
	* 11 * 7	/ () `)	/ () ` ?	1 ^ M ^ T		Woman who prior	itize herself, confider	nt,	Weight	gain, limitations on	functional aspects
	(1)		(1))			hardworking, posi	tive		of the b	ody for physical act	ivity
						Comfortable cloth	200		Comfort	z table one-niece dree	r for a presenant
	v	v v				Comortable clou	165		woman	table one-piece dies	is for a pregnant
	Â	6	3	ର ର	(0)				Function	nal clothes (for an a	ctive social life)
) (((((((((((((((((((& (ñê 🗌	(III)	The Inclusive Deep				,	,
Social						Scenario 1 - Home	(Indoor)				
Aspect	Myself	Family, Fri	iends	Colleague	Crowd	On weekends, the p	protagonist, who is in	postpartum re	covery a	fter pregnancy, takes :	ome time to relax a
	,					home. She spends	her time making cloth	es for the bab	y, doing	yoga, and ensuring sh	e gets the necessar
	Ň					rest. She also prepa	res meals for the fam	ily through co	oking. Th	nese daily activities pri	oritize the
				3 A		protagonist's health	and preparations for	the baby.			
Environmen				min D	(糸)	However, it's menter	ad More details are p	eaded in this	s confide	nce when she showers	and sees her own
tal Aspect					TIL	with negative self-p	erceptions or anxiety	when experier	ncing the	m. Additionally, furthe	r information is
	House	Work pl	lace P	ublic Place	Outdoor	required about the	part where the protag	onist repeate	dly eats i	n the kitchen. An expl	anation of when this
	~			√	√	behavior occurs and	d the emotions the pr	otagonist feel	s while d	oing so would be ben	eficial.
	A		•			Scenario 2 - Outsi	de				
	2 9	DD S			<u>(21) (21)</u>	During weekends, t	he protagonist goes o	ut to meet fri alationching a	ends, spe	ending time at cates a	nd enjoying walks.
Cituration		Т Л	N.	USTE	0.0.0	aids in stress relief.		elationships a	nu provid	se an opportunity to e	njoy nesn an, which
Assest		1 14 11		1711	mmm	On weekdays, the p	orotagonist works at h	er job and is s	somewha	t addicted to it. She p	repares for
Aspect	Daily activities	Job activities	Hobbies	Personal	Social activities	presentations and,	after leaving the office	, enjoys date	nights. T	his part illustrates the	protagonist's work-
				relationship		oriented life and th	e balance between he	r professional	and pers	sonal life.	
	V			V		Moreover, the prota	agonist is mentioned a	is a "pregnant stails about th	: woman.'	* This information is c or and feelings she or	rucial to
Psychologic	Identity	Sociality	Practicality	Individual Taste	Trends	pregnant woman w	ould enhance comme	hension.	ie change	es and reenings she ex	periences as a
al Aspect	√		1		1	Including additiona	I information and spec	ifics about th	ese two :	scenarios will help bet	ter understand the
a ropect						nrotagonist's emoti	ons and experiences				

Fig. 2 Persona spectrum toolkit

Table 3	Participant's FEA checklist
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FEA	Evaluation checklist	1st	2nd
Functional	Have you considered wearability?		
	Have you considered activeness?		
	Have you considered the wearer's protection and safety?		
	Have you considered the convenience of taking off and putting on clothes?		
	Have you considered the flexibility of use (design, size)?		
Expressive	Have you reflected the needs and desires of the wearer?		
	Have you reflected the wearer's social role?		
	Have you reflected the wearer's personality and identity?		
Aesthetic	Have you considered harmony with the wearer's body shape?		
	Have you considered balance and harmony between colors?		
	Have you considered balance and harmony between materials?		
	Have you considered balance between design elements?		

* O (definitely considered) Δ (considered a little).X (unconsidered)

The CLO software, a widely used virtual fitting program, was employed to simulate fashion design ideas on diverse body types. To minimize the technical proficiency gap among participants, the students who had basic skills in operating the CLO software were recruited. All experiments and interviews were recorded by video cameras.

Analysis methods

After the experiments, both the instructors and the students evaluated the IFD education prototype and the P/S toolkit. The instructors who managed the experiments were evaluated pedagogically on all phases of the IFD education prototype. Following the semi-structured interview, the transcription of the instructors' evaluation was organized using the components of the 3C3R model for the educational insights. The transcripts of the students' interviews were subjected to thematic analysis for content analysis following the semi-structured group interviews (two times, ten minutes each).

To evaluate the IFD education prototype on the students' perspective, this study adopted the thematic analysis using the transcriptions of students' interviews. This study followed four phases of the thematic analysis of Vaismoradi et al. (2016) to develop the themes (Table 4). Three experienced coders cross-checked the codes and themes as unanimity. In the first phase of initialization, total 171 in-vivo codes (initial codes) were deducted from the transcriptions. In the second phase, 171 in-vivo codes were grouped into three categories: Design process categories (62), Advantage of IFD education prototype categories (33) and Challenge of IFD education prototype categories (46). Each category was defined as two themes: process/task related theme and planning/environment related theme. In the third and fourth phases, the themes were interpreted regarding the IFD prototype.

Results

Thematic analysis of participants' interviews on IFD process *Fractured structural coding*

For a thematic analysis on IFD process on the learners' perspectives, transcription was conducted after the interviews to derive In-vivo-codes. To make the structural codes, the full transcriptions of interview were segmented related to the given questions and related topics. As a result, 171 fractured structural codes were derived from the transcription. The In-vivo-codes were derived by summarizing sentences that focused on important phrases or keywords in the interview data which were organized. For example, the transcription on the design direction using the needs' analysis on a pregnant office lady in her 20's was summarized 'Design direction for comfortable wear considering a situation where it is difficult due to insomnia and frequent bathroom visits'. After that, core context of In-vivo-codes was deducted as 'Connecting physical features and changes in lifestyle patterns to style.' As a result, 171 In-vivo-codes were summarized and three categories (Design process, Advantage and Challenge of IFD education prototype) were deducted from the fractured structural codes.

Order	Phases	Stages	Outputs (N)
1st	Initialization	Reading transcriptions and high- lighting meaning unit Initial coding and looking for abstraction	In-vivo codes (171)
2nd	Construction	• Classifying • Comparing • Labelling • Translating • Defining	Indexed categories (3) Themes (7)
3rd	Reflectification	Relating themes to established knowledge Stabilizing	Interpretation of themes
4th	Finalization	Developing the story line	Adaptation to IFD process

Tal	b	le 4	4 1	he	matic	ana	lysis	process	and	eac	hр	hase'	s outpu	ts
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Through this process, themes were indexed for each category. The themes of Design process were indexed into process related three themes (research, concept and ideation) and planning related two themes (methods and context). The themes of Advantage were also indexed into two themes (task related theme and environment related theme). The task related theme of Advantage category was subdivided into research, concept, design outputs, process and team communication. And the environment related theme of Advantage category was also subdivided into toolkit and VR software. The themes of task related Challenge were research, concept, design outputs and team communication. Furthermore, environment related themes of Challenge were toolkit, VR software and time. Table 5 shows the fractured structures of codes.

Then, Interpretation of themes were extracted and a developing the story line was compiled. The analysis was conducted using the thematic analysis method, which

Category	Themes		Properties
Design process	Process related	Research	User, needs of the targets, func- tional details
		Concept	Target, TPO, items
		Ideation	Details, Function, versatility
	Planning related	Methods	Using a P/S toolkit, CLO
		Context	Maintaining the concept of inclusive design
Advantage of IFD education prototype	Task related	Research	Finding the needs of targets and solutions
		Concept	Expanded viewpoints, adopt- ing various social issues, various targets, various needs, inclusive concept
		Design outputs	Detailed design, contextual designs
		Process	Incubation process, connectivity of process, relevance of process
		Team communication	Effective collaboration, expand- ing personal ability, active brain storming, expanded design ideas, concretization of ideas
	Environment related	Toolkit	concretization of concept, consistency of design phases, collaborative tool, checking the details of design
		VR software	Structuralizing design, various trials of ideas
Challenge of IFD prototype	Task related	Research	Reference, functional details, difficulties of research
		Concept	Various concept, guide for target setting
		Design outputs	Concreteness of details
		Team communication	Communication method, Ice breaking time
	Environment related	Toolkit	Limitation of toolkit, using order of toolkit, guide of toolkit
		VR software	Proficiency, learning session
		Time	Limitation of time

Table 5 The fractured structure of codes

involved deriving In-vivo-codes from the interview content, deriving categories, deriving themes, and relating themes to established knowledge.

Thematic analysis results on design process

This study has categorized the insights based on the IFD design process and the IFD education prototype into three groups: Design process, Challenge, and Advantage, as depicted in Table 6.

Regarding the IFD process, students expressed difficulties in conducting web-based research for specific targets. Therefore, they suggested that supplementing research methods such as interviews or direct user experience to understand user needs could be beneficial for novice designers. The use of the P/S toolkit was evaluated as helpful for students as it provided diverse perspectives essential for target specification and served as a learning tool to grasp the IFD concept by guiding research directions and factors to consider. However, there was a need for additional guidance on investigating the target during the research process. On the positive side, the IFD process allowed students to expand their targets beyond the initial scope. The research and concept generation stages were closely intertwined, enabling students to incorporate diverse perspectives into their concept development. The IFD process, coupled with the P/S toolkit, facilitated detailed consideration and analysis of physical and psychological characteristics as well as changes in the target's situation and environment. To enhance the effectiveness of the P/S toolkit in the IFD process, it is recommended to provide supplementary materials and specific examples of personas and their corresponding scenarios.

Insights from IFD education prototypes were derived by analyzing Advantages and Challenges (Table 7). Type A students, using the P/S toolkit, faced fewer difficulties during concept and target setting, and emphasized more user research and interviews. Type

Theme		Insights
Process related	Research	Due to the specificity of the target, web-based research is limited. The diversity of research methods is necessary
		Extended research from various perspectives, including physical character- istics, behaviors, lifestyle, psychological needs, and situation-based needs, is required to utilize the P/S toolkit effectively. The research process assists students in understanding the IFD concept
		During the design research process, additional research methods and guidelines are necessary to directly investigate the target and verify the effectiveness of the design
	Concept ideation	Through the IFD process, the students enable to consider not only a prior target but also the extended target during the concept generation
		The concept of inclusive design has allowed the expansion of factors to be considered during the design concept-generation process and enabled new design approaches to be implemented. It has evolved with a focus on functional, psychological, and aesthetic aspects
Planning related	Method	To enhance the effectiveness of the P/S toolkit in the IFD process, it is necessary to provide supplementary P/S toolkit and specific examples of P/S method
	Context	The IFD process and P/S toolkit could encourage detailed and specific consideration and analysis of the physical and psychological characteristics, changes in the target's situation and environment

Table 6 Insights from the Design process themes

	Categories	Type A	Type B
Information concept	Insights from advantage	-Emphasizing connectivity in design planning by expanding the ele- ments to be considered, such as social issues and subject research, to guide the design direction -The IFD process facilitated extensive research on the target providing practical assistance in design development -In the IFD process, research on trends and aesthetics of clothing is conducted in simultaneously	 Differentiated design education targeting various targets Experience to expand design thinking about targets with various needs An opportunity to change the purpose and direction of research routine The concept of inclusive design and problem solving were agonized over at the pre-research stage
	Insights from challenge	 Deciding the topic, scope, and situation from the outset enhances immersion and interest in the target subject The need for Information on Inclusive design Processes and practices Requires research such as direct experience and wearer interviews 	 Difficulty in finding specific data on selected target Difficulties in research on how to solve problems according to the specificity of the target It is necessary to present many examples (costumes, details, interview data, target setting, etc.) at the beginning Suggestion incorporating field surveys or direct user surveys as part of comprehensive training Focused on target problem solving rather than comprehensive target Confused about which part to focus more on in the problem solving
Design outputs	Insights from advantage		and aesthetic part of the design result -Provided Inclusive patterns proved useful in creating the design outputs
	Insights from challenge		 Difficulty in pursuing both functionality and aesthetics at the same time The details were not specified prior to the implementation stage Needs to verify the effectiveness of design results
Team communication	Insights from advantage	-Synergy can be created to solve the target's needs rather than the individual designer's aesthetic opinion -Through the diverse opinions of the team members, we have a comprehensive view according to the concept of inclusive -Time was short but the overall design process was adequate	-Team work was effective, resulting in efficient task completion -Team communication played a crucial role in expanding and refining ideas -Teamwork contributes to shaping the characteristics of the target
	Insights from challenge		 Difficulties on coordinating different ideas among team members Requires various composition of team members and distribution of roles for work efficiency

 Table 7
 Insights from education prototypes

Theme Task related

Theme		Categories	Type A	Type B
Environment related	Process	Insights from advantage		-I was able to think more through the incubation process The phased connectivity of the program was adequate
		Insights from challenge		-If the FEA evaluation indicators were checked before performing the task, a more balanced work could have been done in the planning stage -If feedback on the design continues into the idea developing process, it will help solve practical problems -If a topic, specific scope, or situation is set at the beginning of education, immersion and interest in the persona can be increased
	Toolkit VR software	Insights from advantage	 -An effective tool for a consistent design process A tool for coordination of team communication and step-by-step efficiency A tool to expand the limits of individual competence and concept generation In the inclusive design, CLO is an efficient tool and can immediately check realistic application 	-With the use of CLO, the burden of design production is reduced and various design attempts can be made in a short time
		Insights from challenge	-Example of toolkit required -Necessity to consider the impact of the order of toolkit delivery -Toolkits may limit scope of thinking -By making the toolkit optionally available, more diverse personas can be derived -Feeling the lack of design implementation capability when using CLO -Necessary for CLO education and designation of prerequisite courses	-It would be nice if a body template was provided to effectively sketch ideas
	Tìme	Insights from challenge	-It was difficult to increase diversity and completeness due to lack of time -Need to increase overall experiment time	 Lack of ability to use CLO leads to simplification or changes in design Lack of time for design refinement Insufficient time to use CLO

Table 7 (continued)

Theme

B students, following conventional methods, encountered difficulties in researching the target and problem-solving, and highlighted the need for more examples. Balancing functional problem-solving with aesthetics was proved challenging. Type B students also struggled to address both functional and aesthetic aspects in their design concepts, hindering the generation and adjustment of design details during implementation process. Team collaboration in the IFD process was positively evaluated for analyzing target characteristics, requirements, problem-solving, and idea generation. Type B students suggested providing FEA evaluation factors before the task to achieve a balanced design. Students also requested constant instructor feedback during ideation, which may relate to the need for clear design direction.

The insights on the P/S Toolkit of Type A were deemed essential for maintaining the design concept throughout the process and facilitating effective team communication. Furthermore, it extended individual competence in concept generation. However, they also suggested that the use of the P/S Toolkit should be flexible to avoid narrowing down the scope of thinking and targets.

Instructor evaluation using 3C3R model

To derive the insights from the instructors' perspectives between traditional target setting methods and P/S method in the IFD process, two instructors, who were participated in the experiments, evaluated the education prototypes. They were asked to evaluate each type of IFD education prototype according to the components of 3C3R. The evaluation properties of 3C3R are presented in Table 8.

Contents The instructors identified important educational insights regarding the IFD education prototypes. They highlighted the need for additional content in the prior session to engage students with no experience in IFD and the P/S method.

The evaluation of the P/S toolkit (Type A) and the target setting method (Type B) revealed that Type A facilitated the generation of expanded ideas by considering users'

3C	Properties	3R	Properties
Contents	-Specificity and influence of educational content -Suitability of target or persona/scenario settings -Difficulties in setting up a target or persona/scenario -Influence of education content and toolkit when setting target or persona/ scenario -Adequacy of design tools (CLO)	Researching	•Main research methods and contents •Research time ratio •Limitations of research means
Context	 Context of education content and target or persona/scenario Context of target or persona/scenario and design application Context of inclusive design concept and target or persona/scenario 	Reasoning	 Reasoning for problems and solutions in a set target or persona/scenario Reasoning for solutions in design develop- ment Obstacles to reasoning
Connect	•Connectivity at each stage of the process •Adequacy of the sequence and time of the set process	Reflecting	Interconnectivity of step-by-step learning Learning of new knowledge and scalability of thinking

Table 8 Evaluation properties of 3C3R

changing situations and effectively segmenting design needs and elements. Conversely, Type B tended to limit the scope of the design process to solving problems for a specific target, neglecting the broader user base. The P/S toolkit proved helpful in assessing subject coverage and expanding the content and scope of the persona, leading to a better understanding of inclusive design and guiding the design planning direction.

The instructors also evaluated the CLO as an appropriate design tool for modifying designs for various body types and patterns. However, they noticed that differences in students' proficiency with CLO software could impact the outcome, suggesting the need for prior education or prerequisite courses to ensure all students have a similar level of proficiency.

Furthermore, it is recommended to provide specific design patterns and details of 3D data, as well as research methods.

Context The instructors evaluated that Type A consistently integrated inclusive design principles into their persona and scenario development, establishing strong connections between the persona's physical and psychological situation and their context. However, students in Type B struggled with setting specific targets, situations, and creating contextual designs. Students in Type A demonstrated a stronger ability to establish connections between the target or persona/scenario and design development, considering the context in multiple ways. Conversely, students in Type B tended to narrow the design scope to fit the defined target without expanding the concept of the user, which should encompass a diverse range of users while specifying the target and situation. To ensure that the design process remains inclusive and develops designs for a broader range of users, it is crucial to act, such as regular self-examination and intervention by instructors.

Connect The instructors emphasized team collaboration to enhance the efficiency of connectivity by sharing and reviewing the previous stage's progress before proceeding to the next one. Additionally, they stressed the importance of guiding students to advance to the subsequent stages to prevent excessive stagnation at the target setting stage and to keep the final design goals in mind. For these experiment's education prototypes, which focused on the initial stages of the IFD process (problem finding, target setting, and idea development), it is crucial to establish clear design goals during the planning stage, considering the remaining stages. It was observed that the step-by-step progression is smoother when the direction of target setting and design goals is more specific and well-defined.

Researching The primary means of investigation during the experiment were internetbased research, supplemented by discussions among team members. Most of the research focused on identifying the needs of the target audience rather than the design concept and aesthetics, as was done in previous design planning. Therefore, the instructors mentioned that the students needed assistance in exploring objective and practical data on body characteristics, users' needs, and design approaches, as well as feedback from instructors. They also suggested that to gain a deeper understanding of the problem, it would be helpful to guide the research methods towards conducting interviews with users, as this can provide valuable insights into design methods and examples for problem-solving. *Reasoning* The students in Type A demonstrated the ability to analyze problems and propose solutions from multiple perspectives, resulting in clearer design directions, styles, and details. On the other hand, the students in Type B relied solely on discussions among team members to identify problems related to the targets and situations. However, in some cases, they struggled to reach agreements on the solutions. The instructors attributed this difficulty to the limited focus on a few problems and solutions based solely on the specific physical characteristics of the target. In other words, the lack of specificity in the target and limited situational needs hindered the generation of diverse and comprehensive design ideas.

Reflecting During team collaboration, it was crucial to reach a consensus on decisions at each stage and carry forward prior decisions to the subsequent stages. The instructors emphasized the importance of a reflective mechanism, such as self-inspection (FEA), to maintain the inclusive design concept throughout the process and achieve better outcomes. The IFD education prototypes employed in this experiment facilitated the acquisition of new knowledge and expanded thinking by narrowing down the subjects to establish personas and connecting them with various subject groups.

The design process, which focuses on problem discovery and solutions, the integration of cyclical research processes, and the generation of diverse ideas through teamwork, promotes the acquisition of new knowledge and the expansion of thinking. The instructors assessed that the IFD education prototypes encouraged students to develop their problem-solving skills and think critically about the needs of different target groups through the design process. By engaging in cyclical research processes and collaborative work, students can broaden their knowledge and adopt a more inclusive approach to design.

Discussion

P/S toolkit covering 3R (researching, reasoning and reflection)

In order to provide diverse perspectives on target setting for novice fashion designers, this research project has developed the P/S toolkit and assessed its effectiveness. P/S toolkit was proved as the effective method of comprehending the IFD concept, analyzing targets and concept generation stage. Furthermore, P/S toolkit could encourage detailed and specific consideration and analysis of the physical and psychological characteristics, changes in the target's situation and environment.

Additionally, the toolkit contributed to a better understanding of IFD principles and acted as a supplementary tool to maintain consistency in IFD concepts and promote team communication. Consequently, incorporating the P/S toolkit into IFD education can help novice fashion designers explore relevant factors, establish clear IFD directions, and effectively address design challenges. However, the web-based research to use P/S toolkit had limitations. Therefore, it is important to acknowledge that the use of the P/S toolkit may limit the representation of different user types and their situations. To address this issue in education, it is recommended to develop the contents of the toolkit in multiple versions, covering a wider range of situations and lifestyle

options. Furthermore, direct user research and conducting prior seminars using the P/S toolkit would be beneficial for students to ensure its effective utilization.

Consistency (context, connect) of IFD concept during the education

The findings of the study highlight the significance of consistency throughout each stage of the IFD process. Instead of relying solely on a fashion designer's inspiration or aesthetic approach, a comprehensive understanding and analysis of users using a P/S toolkit directly contribute to design outcomes. Similar sentiments were expressed by Type B participants who indicated that due to uncertain factors during the research stage, design details were determined only during the design implementation stage.

Consequently, it is crucial to incorporate the results from each stage within the context of research, design concept, and specific designs. Both students and instructors emphasized the importance of maintaining consistency and incorporating reflection at every stage. Students claimed that the use of the P/S toolkit was essential to maintain the consistency in the entire design process, while instructors evaluated the role of selfchecklists, such as the FEA of the IFD education prototype, as a mechanism for reflection. Therefore, the P/S toolkit and FEA self-checklist could be the essential methods to make 'Context and Connect' in IFD education.

Importance of team communication in IFD education

The effectiveness of team collaboration in IFD education was highly regarded by most students, regardless of whether they belonged to Type A or Type B. Students emphasized that team communication yielded positive outcomes not only in persona selection and scenario writing but also in target setting and design ideation for usage situations. Emphasizing diverse perspectives on targets and fostering design expansion are crucial aspects of IFD education, and this study primarily investigated their effectiveness through the utilization of the P/S toolkit. However, it was observed that the expansion of various perspectives occurred through team collaboration and effective team communication. Irrespective of the use of the P/S toolkit, individual designers' capabilities were amplified, thus positively impacting the IFD process. In the implementation of IFD education can be further improved by considering various factors such as team composition and the allocation of team roles.

Conclusions

This study aimed to develop an inclusive fashion design education program using a 3C3R model. It involved the systematization of an IFD education prototype and a research tool (P/S toolkit). Thematic analysis was conducted using qualitative data from learners and educators to explore the educational insights of the IFD education prototype and the P/S method. The results of the study showed that the P/S toolkit enabled the students to explore the clear IFD directions and to analyze the specific targets' needs with a multi-perspective. Furthermore, through covering the cognition flow of 3R, the P/S toolkit enrolled as the effective method of IFD education. Consistency throughout each stage of the IFD process was found to be crucial, and the use of the P/S toolkit played

a significant role in achieving this consistency. Both learners and educators recognized the P/S toolkit as an effective guide during the research stage, allowing for the exploration of diverse factors and facilitating design ideation. The P/S toolkit also enhanced understanding of IFD principles, supported consistency in IFD concepts, and promoted team communication. The effective team communication using the P/S toolkit actively generates diverse ideas, integrates problem discovery and solution finding, and involves cyclical research processes. Therefore, team communication fosters the acquisition of new knowledge and expands thinking in IFD education. For future research, it will be essential to increase participant numbers, diversify team composition, and broaden the scope of toolkit contents in order to disseminate the research findings across the field of design education. The findings of this study hold significance as they introduce an education model and methodology for promoting the dissemination of IFD education. This contribution has the potential to foster the widespread adoption of diversity in fashion education and industry.

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Author contributions

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This research was conducted under the approval and supervision of Yonsei University Institutional Review Board (IRB Approval No: 7001988-202210-HR-1719-01) regarding ethical issues including consent to participate.

Consent for publication

Competing interests

Not applicable.

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