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Reflection on Value and Function of Information Technology Curriculum from the Reform of the British ICT Curriculum

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Abstract: In the context of social transformation, the needs of society and individuals for information technology are changing, and discussions on the value and function of information technology are getting more and more attention. The purpose of this research is to clarify the value problems of the information technology curriculum and its function for nurturing students in primary and secondary schools. This research adopts content analysis and comparative research methods, which focus on the process, content selection, and implementation status of information and communication technology (ICT) in the Computing curriculum of British primary and secondary schools. This research content is based on an analysis perspective of curriculum value theory from levels of social and human development, and finally formed the analysis framework of value in information technology curriculum standards. The research results analyze reasons for changes in the value orientation and practical performance of the information technology curriculum standards in Britain to help understand trends and challenges of information technology reform in different contexts. Finally, this research finds the effects of content and value changes of curriculum standards on social and student development and puts forward conclusions for the position and value of information technology in the future of learning and teaching in the context of educational informatization.

Keywords: information technology; curriculum reform; curriculum value and function

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1. Introduction

In a world that is rapidly embracing digital technology as the primary medium of communication, students need to be able to gather and use online information [1]. Education needs to emphasize providing every citizen with flexible digital skills to meet challenges and revisit investments in education [2]. With the transformation of the industrial society to the information society, the needs of individuals and society have changed, and different understandings of individual and social values have emerged. Information technology curriculums naturally need corresponding values under social transformation [3]. In the digital environment, it is necessary to distinguish what is valuable and applicable knowledge for learning. Such an environment is considered created where schools can use technology to support innovation and spread evidence-based practice in Britain [4]. At various times, it is necessary to confirm the value ontology of information technology curriculums, explore the value uniqueness of information technology curriculums, and guide people to dialectically view the value of information technology.

The value of information technology itself is significant in promoting the role and function of information technology in the field of education in different subjects. It refers to its utility and significance to people and society, which is affected by multiple factors in society and education in this research. Britain, as a typical developed country, has an early development of information technology education. This study chooses the British information technology curriculum as the object of study mainly because of its relatively well-developed policy, curriculum system, technical support, resource construction and

financial support. Specifically, we focus on England in Britain because political initiatives have led to accelerated changes in computing education there. With the development of time and the changes in students, the existing ICT curriculum in primary and secondary schools in Britain was questioned and criticized by academics and industries [5]. The reform of the British information technology curriculum is not a rapid denial of the achievements and impact of the original curriculum but after a civil critical reflection and academic investigation of the original curriculum results and current status [6–8]. Moreover, the British information technology curriculum changed to meet society's needs and talent development [9]. From the original ICT curriculum to the current Computing curriculum, British information technology curriculums have undergone profound changes in the curriculum, standards and value settings.

In the face of the demands of information technology and education modernization in the new era, there is still a gap among the content, stance, implementation of the curriculum standards and their ideal state. Researchers need to further understand the value and function of the information technology curriculum in order to clarify its disciplinary nurturing value and its value of deep integration in different disciplines of education, with a view to maximizing the function and value of information technology in educational activities. Based on the above analysis, this research mainly solves the problem of the curriculum value orientation and the specific performances behind the values reflected in the change of the information technology national curriculum standards in British primary and secondary schools. The theory and analytical framework of curriculum value are used in this study to analyze the reform context and development characteristics of changes in ICT and Computing curriculum standards. Specifically, the following questions need to be solved: (1) What are value orientations and specific performances behind the values reflected in the change of the ICT curriculum standard to the Computing curriculum standard in Britain? (2) What are the factors affecting the value changes for the ICT curriculum and Computing curriculum in Britain? (3) From the perspective of learning and teaching, what is the implementation status of the Computing curriculum in Britain?

2. Background

2.1. ICT Curriculum Standards' Background

The information technology discipline and the corresponding curriculum standards were set separately for the first time as one of the basic curriculums in 1994. The goals of ICT abilities that students should master were explained in detail. The national curriculum standards for the first time put forward the new concept of 'information technology and curriculum integration', requiring schools to apply the application of information technology to the teaching of various compulsory curriculums in the country. It uses ICT as the subject name and essential core skill for students. It emphasizes the importance of ICT application in interdisciplinary teaching. As a result, the content and thinking of information technology education in the UK have changed from cultivating students by simply applying information technology to in-depth understanding and application of information [10]. The third edition of the national curriculum was implemented and its content system divides primary and secondary schools into four key stages (1–4), which have corresponding curriculum standard content and assessment levels.

2.2. Computing Curriculum Standards' Background

There was a report released to describe and analyze the development of computer science in primary and secondary schools [11]. The report was concerned that England was producing significantly fewer computer scientists and IT professionals than were needed by industry, and that those school leavers had a dissatisfactory level of ICT skills for work in even non-technical jobs. The Royal Society released a report that mainly analyzed the current situation of computing education in primary and secondary schools in Britain. It mainly suggested that the implementation of computer education in most British schools was not satisfactory. There is a severe shortage of teachers in the information technology

sector and there is a lack of continuity in professional development [12]. The national curriculum identifies computing as a mandatory subject at Key Stages 1 to 4 and that 'a high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world' [13]. In 2014, the Department for Education officially used the computing programmes of study and replaced ICT as a national curriculum subject at all key stages in England. The national curriculum standard in England set four key stages for different age groups from 5 to 16. Key Stage 1 is for 5–7 years old (Years 1–2), Key Stage 2 is for 7–11 years old (Years 3–6), Key Stage 3 is for 11–14 years old (Years 7–9) and Key Stage 4 is for 14–16 years old (Years 10–11) [14]. The computing curriculum includes computer science (knowledge of computers and computation), information technology (a context for the use of computers in society), and digital literacy (skills and knowledge required to be an effective, safe and discerning user of a range of computer systems) [13]. Specifically, computational thinking is essential for students to solve problems, design systems, and understand the power and limits of human and machine intelligence [15]. Students who can think computationally are better able to understand and use computer-based technology and are better prepared for today's world and the future [16].

3. Theoretical Framework

3.1. Values

There is a comprehensive discussion on using the concept of value in educational research. Values are core concepts to explain the organization and change of societies and individuals [17]. They play an essential role in disciplines such as education, sociology, psychology and anthropology. In addition, values are used to describe cultural groups, societies, and individuals, to track changes over time, and to explain the motivational basis of attitudes and behavior [18]. Schwartz (1994) defines values "as desirable, trans situational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" [19]. Inglehart and Welzel's definition of value is similar to Schwartz's: "Value orientations set standards for desirable and undesirable goals" [20]. Inglehart infers the specifics of goals from Maslow's hierarchy of needs. The hierarchy of needs implies that once basic material needs are met, humans develop higher needs for self-esteem and self-actualization [21]. Values can be expressed through behavior and have cognitive or rational nature. Halstead and Taylor refer to values as "the principles and fundamental convictions which act as general guides to behavior, the standards by which particular actions are judged as good or desirable" [22]. However, the application of value construction in the social sciences is hindered by a lack of consensus on fundamental values, the content and structure of the relationships among these values, and reliable empirical methods for measuring these values.

3.2. Curriculum Values

The curriculum reflects a country's values and aspirations for its young people. It aims to express what is considered to be important knowledge and to promote the development of values through learning and teaching [23]. Curriculum values are the main threads that guide the development of the curriculum. They lie in the satisfaction of the subject's needs (individual and society). The essence of the curriculum value is the dialectical unity of the curriculum's attributes and the needs of the individual and society [3]. Specifically, the value of the curriculum refers to the curriculum that satisfies the needs of educators, educated people and society. Researchers also have different understandings of curriculum values, such as intrinsic and instrumental values, social and personal values, ideal values and practical values. Dewey, as a representative in the field of American educational research, divides values into intrinsic value and instrumental value [24]. Intrinsic value can also be called appreciation value, which refers to the value of curriculum knowledge itself. Instrumental value can also be called tool value, which means that curriculum knowledge has value as a means to achieve a particular end.

3.3. Curriculum Value Orientations

Value orientations refer to a complex combination of beliefs, intentions and actions in practice, which guide teachers to interpret and implement the curriculum [25–29]. Specifically, value orientations are "belief structures or philosophical positions that can be defined operationally in educational settings. They influence the teachers' emphasis on the learner, the context and the body of knowledge" [26]. Value orientation influences teachers' emphasis on learners, contexts, and knowledge systems, as well as curriculum decisions, student learning goals, and academic and behavioral expectations for success [25]. From a curriculum perspective, curriculum value orientations arise from beliefs and have a significant impact on education [30]. Curriculum scholars discuss that value orientations impact curriculum decisions and lead to determining choices related to content, pedagogy, learning method and assessment. The curriculum value orientation guides teachers in planning and practice. The practical significance of curriculum values is that they have the potential to be used as an important tool in teacher education, providing insight into student teachers' preferences and decisions regarding planning, pedagogy, content selection and practice, as these are based on their particular beliefs and values [31,32]. In 1992, Ennis concluded that curriculum value orientations "influence decisions related to content selection and implementation" [26]. Pratt defines perspectives on teaching as "an interrelated set of beliefs and intentions that gives direction and justification to our actions" [29]. Furthermore, the importance of explicit values in coursework of any nature is now widely recognized and reflected in official course documents and texts used for curriculum and instructional research.

3.4. Values in Information Technology Curriculum

The value of the information technology curriculum defined in this research includes curriculum value orientations, specific value performances and value relationships between education stakeholders, education context and education media in information technology disciplines.

3.4.1. Characteristics of Values in Information Technology Curriculum

The characteristics of values in the information technology curriculum include objectivity and subjectivity, historicity and time validity, and individuality and diversity. The discipline of information technology has its own unique principles, methods and knowledge. The objectivity of the information technology curriculum value is mainly determined by the information technology discipline itself [33]. Furthermore, as the subjectivity of curriculum value, students need to be concerned with their needs and future social life and development. The historical value of the information technology curriculum refers to the value impact of the changes in the subject, object, and environment on the information technology curriculum under different periods. The value of information technology curriculums is only a temporary period of value choice. The time validity of value means that as the subject changes and develops, the value of the object to the subject will change accordingly. Individuality is mainly reflected in students' personal interests and their needs for information technology at the various key stages. As the subject has different needs, a diversity of values will be produced. Specifically, for individual students, information curriculum value is knowledge and skills value, process and method value, etc. For society, information curriculum value mainly refers to the political value, economic value, cultural value and moral value, etc.

Value is the satisfaction relationship between the needs of the subject and the object's attributes. In this study, we mainly emphasize the needs of both the individual and social levels. Therefore, the values of information technology curriculums mainly refer to satisfaction between information technology curriculums, society and individuals. The social subject needs of information technology curriculums are mainly the needs arising from the information society, information culture, digital divide, information ethics, knowledge society and the era of globalization. The individual subject needs of information technol-

ogy curriculums are mainly the needs arising from information technology knowledge and skills, information technology processes and methods, and information technology perspectives and attitudes.

3.4.2. Levels of Values in Information Technology Curriculum

Values in the information technology curriculum can be constructed from multiple dimensions and levels. The National Curriculum subjects can be used for teaching and developing moral values, cultural values or other values [34]. The development characteristics, rules and tasks of students determine the value orientation of the information technology curriculum and also affect the goals, content selection and activity methods of the information technology curriculum. Therefore, the core value of the information technology curriculum is the development value of students.

This study mainly adopts Maslow's hierarchy of needs to construct levels of values in the information technology curriculum. Maslow believes that people's psychological needs are hierarchical, from low to high levels are physiological needs, safety needs, belongingness and love needs, esteem needs, and self-actualization needs [35]. Maslow believes that the human value system has low-level needs and high-level needs. There are five different levels of needs hidden in people but the urgency of the needs shown in different periods is different; when people's needs at a certain level are met, they will pursue the needs of higher levels; high-level needs are more valuable than low-level needs. The above statement shows that human needs are hierarchical, which is very helpful to understand the hierarchical value of information technology curriculum from the needs of students to adapt to their future social life.

Based on the above analysis, this study divides the value of the information technology curriculum into three aspects: cognitive value, moral value and cultural value, and divides its value according to the level of needs from low to high (see Figure 1). Cognitive value mainly refers to the basis for students to recognize the discipline knowledge and to meet the students' needs for knowledge. Moral value primarily refers to the humanistic care of information technology to society, others, and individuals, thinking about the opportunities and challenges that information technology brings to human society and fulfilling personal responsibilities and obligations in the information society. Society shapes cultural values and there will be unique cultural needs in different social forms. In this study, cultural value mainly refers to the shared value, choice value, and application value of satisfying students' learning of information technology curriculum in the context of an information culture society.

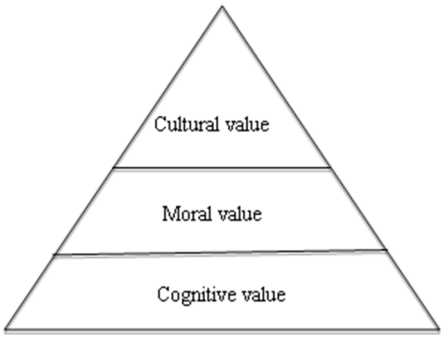

Figure 1. The Value Level of Information technology curriculum.

3.4.3. Construction of Information Technology Curriculum Value System

The construction of value system in subject curriculums was seen in information technology (intrinsic value of the individual: knowledge and operating skills of information technology, information processing methods and skills, ability, emotions and attitudes, and social responsibilities; individual instrumental value: survival value, development value and enjoyment value; social value: bridging the digital divide, building information culture,

information society) [3], geography (cognitive value, moral value and aesthetic value) [36] and in the physical (discipline mastery, learning process, self-actualization, ecological integration, and social responsibility) [37,38], etc. in the existing literature. Moreover, these are widely discussed when constructing information technology curriculum value, which covers the value of ICT to the curriculum of academic subjects, cross-curricular, or school-wide, either to facilitate curriculum change and educational reform, to improve the teaching and learning of existing content, to facilitate understanding of new objectives or to promote a new vision of teaching and learning [39]. The English Computing curriculum is a system for developing abilities and intelligence to support self-enhancement in an individualistic society, such as wealth, success, ambition, competence, intelligence, power [40]. It serves as a means of developing personal skills for economic gain and success and contributes to self-enhancement in a broader social and political context [41]. Based on the above existing literature and information technology curriculum in England, this study constructed the value system of information technology curriculum with specific value performances. The value of the information technology curriculum is mainly divided into cognitive value, moral value, and cultural value, and there is a hierarchy between the three. Cognitive value can be divided into knowledge and operation value, processing method and skill value, competence value, practice and integration value, computational thinking value and comprehensive thinking value as specific value performances. Moral value can be divided into information social responsibility value, information ethics value, and personal information security value as specific value performances. Cultural value can be divided into shared value, choice value and application value of information culture as specific value performances (see Figure 2).

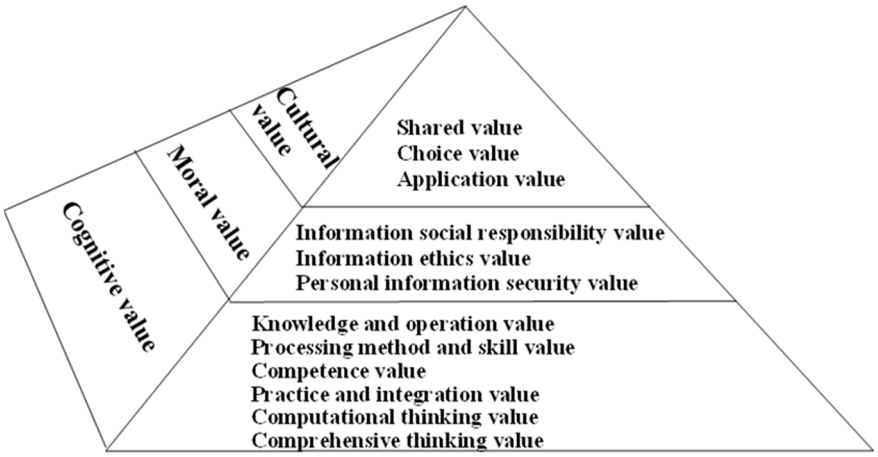

Figure 2. Information technology curriculum value system.

The cognitive value of an information technology curriculum is to meet the needs of students to understand the world, discover the laws of information technology curriculum, observe the world from the perspective of information technology, and change the world with the operation of information technology. The moral value of the information technology curriculum is to meet the needs of students' own behavior norms and to evaluate the significance and rationality of human behavior. It is an important indicator of whether humanistic care is achieved and it is based on cognition, which is the key to improving the spiritual realm of the curriculum and realizing the development of a student's personalization. Cultural value is based on cognitive value and moral value and it is the satisfaction and freedom that exceeds utilitarian needs. The cultural value of the information technology curriculum is to meet the needs of students' development and critical innovation. This value places the curriculum on various of social, political, economic, and cultural backgrounds. It connects the personal deep life experience and spiritual world to seek the meaning of the curriculum.

4. Methodology

This research mainly uses the content analysis method to analyze the curriculum value orientation and key influencing factors behind the information technology curriculum reform. It also analyzes the curriculum-specific value performances and changes brought by the curriculum standards, learning status and teaching implementation. In addition, a comparative research method was used to longitudinally compare the ICT and Computing curriculum standards of British primary and secondary schools and found the difference between the changed curriculum value orientation and curriculum-specific value performances.

The research framework developed in this research quantitatively analyzes the subject content of the ICT and Computing curriculum standards in British primary and secondary schools. The quantitative content analysis mainly focuses on the content-coding and frequency count of the subject content in the ICT curriculum standards and Computing curriculum standards of British primary and secondary schools. It mainly conducts two aspects of comparative analysis, including comparative analysis of specific value performances in the subject content of the ICT curriculum and Computing curriculum at different key stages, and comparative analysis of specific value performances in the subject content of the ICT curriculum and Computing curriculum at the same key stage. This study also qualitatively analyzed student learning, teacher teaching situation, subject content, value orientation and specific value performances of the curriculum standards.

4.1. Content Analysis Method

4.1.1. Select the Content Analysis Framework

The analysis framework of specific value performances and index systems for curriculum standards is further determined based on the established curriculum value system and information technology curriculum standards in British primary and secondary schools. The first-level index includes three aspects: cognitive value, moral value and cultural value. The value range of the first-level index is comprehensive and other disciplines have the above value. The selection and establishment of a second-level index focus on specific disciplines. Therefore, it is necessary to further refine the second-level index according to the nature of information technology. The second-level index should highlight the structural, systematic and disciplinary nature of the information technology curriculum.

4.1.2. Trial the Content Analysis Framework

To understand the feasibility and effectiveness of the value analysis framework of the curriculum standards, this study first conducted trial coding and reliability testing on the ICT curriculum standards and Computing curriculum standards. In this study, a total of three coders participated in the coding work. They are mainly researchers involved in the development of information technology curriculum standards for primary and secondary schools. They completely understand the content and value performances of the information technology curriculum standards in Britain. The coder performs independent coding to ensure the reliability of the coding result. Before coding, the coders were trained to understand the index system. The coders code specific subject content and curriculum objectives in the standards according to the second-level index. For example, 'use logical reasoning to predict the behavior of simple programs.' This can be classified as 'processing method and skill value' and is coded as A2. In addition, some coding items can be divided into multiple values. For example, 'understand several key algorithms that reflect computational thinking [for example, ones for sorting and searching]; use logical reasoning to compare the utility of alternative algorithms for the same problem.' The above subject contents are divided into 'processing method and skill value' and 'computational thinking value' and are coded as A2 and A4. During the encoding process, the coder does not discuss the coding content. If there is any objection to the coding, the coder can discuss the content of codes with significant differences after the end of the encoding, and finally, determine the result of the encoding. Before the formal coding, the author tried out the

proposed analysis framework and randomly selected about 20% of the content items in the ICT curriculum standards and Computing curriculum standards of British primary and secondary schools for trial coding. The coding staff discussed the analysis framework based on the above problems and determined the final formal coding standard for use in carrying out formal coding work. In addition, the classification of value performance was refined by capturing keywords.

The calculation of reliability in this study uses Holsti's method and percent agreement. The general reliability coefficient is 90% or more. The reliability in this study is 90.9%. Based on the above results, the reliability meets the theoretical requirements, and the reliability test methods and results meet the research standards.

4.1.3. Determine the Content Analysis Framework

After the trial coding, the final analysis framework for the specific value performances of the information technology curriculum standards in British primary and secondary education is finally determined (see Table 1).

Table 1. The analysis framework for the specific value performances of information technology curriculum standards in British primary and secondary education.

First-Level Index	Second-Level Index	Code Basis
A Cognitive value	A1 Knowledge and operation value	Knowledge and operation of information technology discipline
	A2 Processing method and skill value	Processing method and skill of information technology discipline
	A3 Competence value	Competence in Information technology discipline
	A4 Computational thinking value	Computational thinking mode of information technology discipline
	A5 Comprehensive thinking value	Comprehensive thinking mode of information technology discipline
	A6 Practice and integration value	Integration approach and attitude to information technology discipline
B Moral value	B1 Information social responsibility value	Information technology humanistic care for society
	B2 Information ethics value	Information technology humanistic care for others
	B3 Personal information security value	Information technology humanistic care for individuals
C Cultural value	C1 Shared value of information culture	The influence of student information literacy on cultural sharing and blending
	C2 Choice value of information culture	Students criticize and choose information culture in order to adapt to the knowledge society of information technology
	C3 Application value of information culture	Students innovate, understand and develop information culture

Cognition refers to the process by which people acquire or apply knowledge. This study mainly classifies and refines the cognitive value based on the division of cognitive learning results in Gagne's cognitive psychology. Gagne divided the learning results of the cognitive field into the following aspects, which include verbal information, intellectual skills, cognitive strategy, motor skills, and attitudes [42]. The educational value of students

in the cognitive field of curriculum learning is not only reflected in explicit knowledge and learning skills but also implicit in the learning of cognitive strategies. The knowledge and operation (A1) mainly refer to satisfying students to acquire basic and cutting-edge knowledge content of information technology in the curriculum standards and to understand the main concepts of data, algorithms, programs, computers, communications, the internet, and information society. Processing method and skill (A2) mainly refers to the effective information processing methods and skills required by students in the curriculum standards. Students can use information technology tools, software and resources to process and analyze information through course learning. Competence value (A3) mainly refers to the ability to navigate, evaluate and create digital artifacts effectively, responsibly, safely and critically using a range of digital technologies. Computational thinking (A4) mainly refers to students using computational thinking to solve problems. It allows students to solve problems, break them down into solvable chunks, and design algorithms to solve them. Comprehensive thinking (A5) mainly refers to the comprehensive technology of information technology curriculum objectives, content and forms that reflects a variety of scientific technologies and social abilities. Practice and integration (A6) mainly refer to the integrated approach of information technology disciplines. The attitude of students to participate in the practice of information technology is particularly important for the realization of practical value. The integration of information technology and curriculum can build an information-based learning environment, which is an important way to cultivate and improve students' abilities and qualities across the different subject curriculums.

Moral value refers to the moral meaning of personal behavior to self, others and society. Information technology humanistic care for society (B1) mainly refers to the responsible, reasonable and safe use of information technology, and the behavior of information technology conforms to social laws, regulations and ethics. Individual students can fulfill their responsibilities to the information society. Information technology humanistic care for others (B2) mainly refers to observing public norms, effectively safeguarding individuals' legitimate rights, and interests in information activities and respecting the intellectual property rights of others. Information technology humanistic care for individuals (B3) mainly refers to the need for individuals to increase awareness of information protection, understand the principles of passwords and other privacy tools, and prevent personal privacy information.

Cultural value refers to the fact that an information technology curriculum needs to undertake critical innovation while undertaking cultural inheritance and effectively promote the development of students. The shared value of information culture (C1) mainly refers to social needs that enable students to have an impact on information culture. Information culture sharing not only means more opportunities for learning information resources but also means that information sharing culture promotes global knowledge sharing and cultural integration. The choice value of information culture (C2) mainly means that students can choose the information culture that meets their needs, and criticize the bad information culture, emphasizing that students can make independent choices and self-designs in information culture activities. The application value of information culture (C3) means that students can actively apply what they have learned to solve problems in their learning life. Students can develop and improve their information literacy by understanding information culture and innovative practices.

4.2. Comparative Research Method

This study focuses on the key influencing factors, subject content, and implementation status of the reform of information technology curriculum standards in British primary and secondary schools. This research conducts a vertical and horizontal comparison of the value orientation, specific value performances, development process, aims, and subject content of Computing and ICT curriculum standards.

5. Results

5.1. Comparison of Aims and Values under the Reform of Curriculum Standards

The English Computing curriculum standards were formulated based on early criticism and comparison with the ICT curriculum, and there were significant changes made in terms of curriculum names, the purpose of study, aims, and learning content. The ICT learning plan mostly emphasizes students' usage and exploration of ICT and knowledge to confidently complete assigned objectives and develop thinking. The overall framework of the Computing programs of study mainly consists of the purpose of study, aims, attainment targets and subject content. The core and foundation of the Computing program is computer science, in which students learn the principles of information and computing, how digital systems work and how to use this knowledge through programming. In addition, the application of the Computing curriculum emphasizes that students can use information technology to create programs, systems and a range of content.

ICT and Computing curriculum standards mainly include learning goals and curriculum objectives with specific value performances (see Table 2). In terms of learning objectives, ICT curriculum standards are primarily aimed at students' understanding of information technology knowledge and the application of information technology tools. The Computing curriculum standard learning objectives mainly elaborate students' understanding of computer knowledge and computational thinking, emphasizing that through cultivating digital literacy and developing interdisciplinary ability, students can use information technology for knowledge creation and reuse. Moreover, students can actively become involved in the future digital society to adapt to the challenges posed by future work.

Table 2. The learning and curriculum objectives of ICT and Computing standards with specific value performances.

	ICT Standard	Computing Standard
Specific value performances of learning objectives	• knowledge and operation value • processing method and skill value • competence value • practice and integration value	• computational thinking value • comprehensive thinking value • competence value • practice and integration value • knowledge and operation value • application value of information culture.
Specific value performances of curriculum objectives	• processing method and skill value • information social responsibility value • choice value of information culture	• computational thinking value • comprehensive thinking value • knowledge and operation value • practice and integration value • competence value • information social responsibility value • information ethics value • personal information security value

In terms of curriculum objectives, ICT curriculum objectives mainly describe the processing methods and skills, as well as the role and development of curriculum in

the information society and information culture. The Computing curriculum objectives are more specific, emphasizing the understanding and application of computer science knowledge, the ability to use computational thinking to analyze and solve problems, and the ability to evaluate and apply information technology to solve problems. The curriculum focuses on the responsible, competent, confident and creative usage of ICT.

It can be seen from Table 2 that learning objectives and curriculum objectives are gradually refined and enriched, and the subject knowledge and thinking methods are progressively deepened. The value orientation gradually changed from tool application value to professional subject value. For the implementation of the Computing curriculum, the Computing curriculum does not entirely abandon traditional education but provides opportunities for enriching, deepening and improving the existing curriculum education. For educators, it is necessary to inherit and innovate the teaching content, ideas and methods of instruction.

5.2. Comparison Results of Specific Value Performances

5.2.1. Comparison Results and Analysis of Specific Value Performances in the ICT and Computing Curriculum Content in Different Key Stages

Through the statistical analysis of relevant data, the ICT curriculum reflects the corresponding and targeted curriculum value in different key stages (see Figure 3).

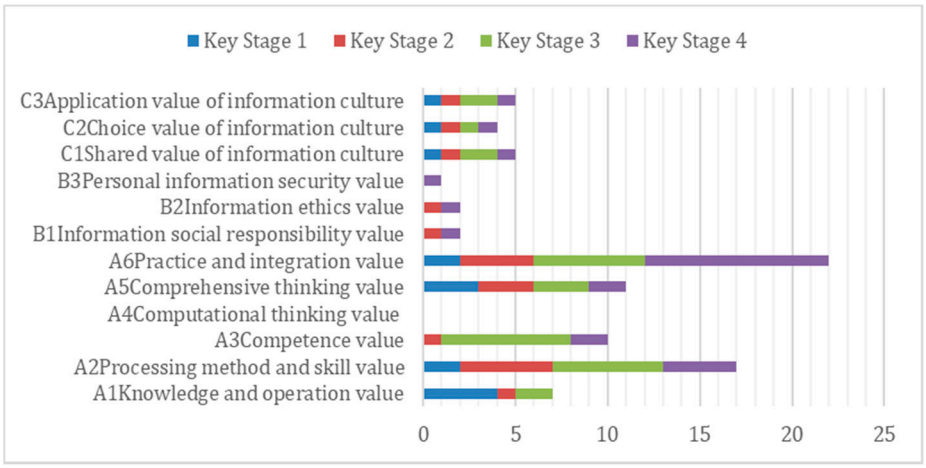

Figure 3. Bar graph of specific value performances frequency of ICT curriculum content in different key stages.

As shown in Figure 3, the statistical results show that the value of ICT subject content under the four key stages is different. There is a lack of description of moral value in the content of Key Stage 1 and Key Stage 3. However, it focuses on students' cognitive values and cultural values, especially in Key Stage 3. In the context of Key Stage 2 and Key Stage 4, there are references to cognitive, moral, and cultural values. Among them, Key Stage 4 describes more cognitive and moral values. Based on the comparison of the above results, it is found that there are differences in the specific value performances of the ICT curriculum in different key stages, which generally emphasizes the cognitive value and cultural value of the curriculum. With the improvement of students' cognition levels, the value of cognition presents a trend of increasing by key stages. The cultural value develops in a balanced way in different stages, and students can study courses in the context of information culture. Cognitive value attaches importance to the practice and integration value, presents a situation of increasing by key stages, and then emphasizes the processing method and skill value, the value of comprehensive thinking, which confirms that the information and communication technology courses attach importance to application value. The description of moral value is insufficient in four key stages, showing that the content of moral value is inadequate and urgently needs to be added.

Through the statistical analysis of relevant data, the Computing curriculum reflects the corresponding and targeted curriculum value in different stages (see Figure 4).

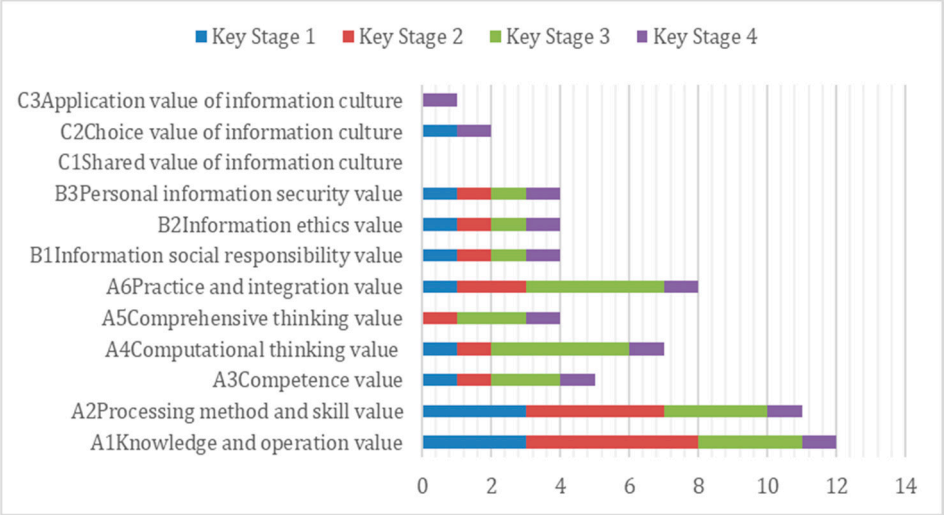

Figure 4. Bar graph of specific value performances frequency of Computing curriculum content in different key stages.

As shown in Figure 4, the statistical results show that specific value performances of the Computing curriculum under the four key stages of students are different. The four key stages emphasize cognitive value and moral value, and Key Stage 1 and Key Stage 4 emphasize cultural value. In Key Stage 1 and Key Stage 4, the specific value is expressed as cognitive value, followed by a moral and cultural value. In Key Stage 2 and Key Stage 3, the value performance is cognitive value, followed by a moral value. Based on the above comparison results, it is found that the Computing curriculum emphasizes the value of subject knowledge in different stages, moral education is used for students to use knowledge effectively, reasonably and responsibly, with less description of cultural value. Moreover, the ICT curriculum emphasizes more on cultural values than moral values. From the above analysis, in the continuous development of information culture, information technology courses gradually began to pay attention to the role of morality in the healthy development of information technology. The Computing curriculum pays special attention to developing the value of computational thinking in each key stage. Key Stage 3 is the stage that develops the most value of computational thinking, which is closely related to students' knowledge and operation, the processing methods and skills, the practice and integration, competence value and the development of comprehensive thinking value. The subject curriculum content and value between the key stages are cohesive and complementary.

5.2.2. Comparison Results and Analysis of Specific Value Performances in the ICT and Computing Curriculum Content in the Same Key Stage

The statistical analysis of the data shows that the ICT and Computing curriculums have common and different values for the same level of study. There are commonalities and differences in the value of ICT and Computing courses across the four key stages, which are analyzed below (see Table 3).

Table 3. The ICT and Computing curriculum standards with specific value performances in key stages.

Key Stages	Curriculums	Cognitive Values	Moral Values	Cultural Values
Key Stage 1	ICT curriculum	×		×
	Computing curriculum	×	×	×
Key Stage 2	ICT curriculum	×	×	×
	Computing curriculum	×	×	
Key Stage 3	ICT curriculum	×		×
	Computing curriculum	×	×	
Key Stage 4	ICT curriculum	×	×	×
	Computing curriculum	×	×	×

Both two curriculums in Key Stage 1 are concerned with cognitive value, especially the ICT curriculum pays great attention to the knowledge and operation value, and also attaches great importance to the value of comprehensive thinking, practice and integration value, and processing method and skill value. The Computing curriculum pays high attention to the processing method and skill value, the knowledge and operation value, competence value, computational thinking value, and practice and integration value. In addition, both the ICT curriculum and Computing curriculum focus on cultural values, and the ICT curriculum focus on cultural values (shared value of information culture, choice value of information culture, and application value of information culture). The Computing curriculum pays special attention to moral values (information social responsibility value, information ethics value, personal information security value), while the ICT curriculum lacks a detailed description of moral values.

ICT curriculum content and Computing curriculum content both pay special attention to the cognitive value of students in Key Stage 2. The focus of the Computing curriculum is the knowledge and operation value, the processing method and skill value, followed by practice and integration value, computational thinking value, comprehensive thinking value, and competence value. The ICT curriculum focus on the processing method and skill value, practice and integration value, and comprehensive thinking value, followed by knowledge and operation value and competence value. In terms of moral value, the specific value performances of the ICT curriculum are lower than that of the Computing curriculum. The ICT curriculum focus on emphasizing the value of information social responsibility and information ethics, while the Computing curriculum pays attention to information social responsibility value, information ethics value and personal information security value. In terms of cultural value, the ICT curriculum provides a more specific description of the cultural value, paying attention to the shared, choice and application value of information culture. In contrast, the Computing curriculum does not explicitly describe the relevant cultural value.

In Key Stage 3, the ICT curriculum focuses on the competence value in cognitive value, followed by the practice and integration value, processing methods and skills value, the value of comprehensive thinking, and knowledge and operation value. The Computing curriculum pays more attention to the value of computational thinking, the practice and integration value, the processing method and skill value, and the knowledge and operation value, followed by competence value and comprehensive thinking value. In terms of moral value, the Computing curriculum focuses on the value of information social responsibility, the value of information ethics, and the value of personal information security, while the ICT curriculum lacks a description of the specific value performances of moral value. In terms

of cultural value, the ICT curriculum focuses on the shared value of the information culture and the application value of the information culture, followed by the choice value of the information culture but the Computing curriculum lacks a description of the cultural value.

In Key Stage 4, the ICT curriculum and Computing curriculum focus on three aspects: cognitive value, moral value, and cultural value. The ICT curriculum has the most description of information technology practice and integration value in cognitive value, followed by information technology processing method and skill value, competence value, and the value of comprehensive thinking. Both curriculums describe moral values in details. In the cultural value, the Computing curriculum lacks a detailed description of the shared value of information culture, that is, the influence of student information literacy on cultural sharing and blending. Both curriculums describe the choice and application value of the information culture.

In summary, there are differences between the two curriculums in the same key stage regarding the value of the curriculum and the focus on the performance of specific values. It is mainly reflected in the difference between the description of moral value and cultural value in Key Stage 1, Key Stage 2, and Key Stage 3. The ICT curriculum lacks attention to moral value in Key Stage 1 and Key Stage 3, highlighting the cognitive value (knowledge and operation value, processing method and skill value, competence value, comprehensive thinking value, practice and integration value) and cultural value (shared value of information culture, application value of the information culture, choice value of information culture), emphasizing the value of applying and practicing information technology tools at different stages according to the relevant information culture environment. However, it lacks information in-depth understanding, learning of computer science discipline knowledge, computational thinking, information technology ethics and personal information security awareness. Compared with the Computing curriculum, it lacks a description of cultural value in Key Stage 2 and Key Stage 3, with an emphasis on cognitive value and moral value. It pays much attention to the value of computational thinking, the knowledge and operation value, the processing method and skill value, the value of practice and integration, the value of information social responsibility, the value of information ethics, and the value of personal information security. It emphasizes the critical influence of computational thinking on problem-solving, with particular emphasis on the ethical standards of information technology activities carried out by individuals and society considering the cognitive processes and knowledge of students for the development of students in society.

6. Discussion and Conclusions

Each change to the curriculum standards is a re-interpretation of the curriculum and further improvement of it in practice. Information technology is a fundamental subject in the curriculum system of primary and secondary schools, focusing on the improvement of students' information competence, helping students master the basic knowledge and skills of information technology, enhancing information awareness, developing computing thinking, improving digital learning and innovation capabilities, and establishing the correct information society value [40]. The value foundation of the information technology curriculum mainly comes from the belief in education, it is necessary to promote the spiritual, moral, cultural, mental and physical development of students in schools and society, and also provides opportunities, responsibilities and experiences for students to study in school. The subject's content clearly emphasizes the importance of professional knowledge in computing science. Students pay more attention to learning computer and computing science knowledge, not just learning how to use technology. Turning now to the Computing curriculum developed by information technology can also be used in a cross-curricular way. Furthermore, the value of the Computing curriculum focuses on the combination of science and humanities, reflecting the value orientation of people's all-round development. From the perspective of social and human development, deepening the understanding of the value system of information technology curriculum can promote

changes in value orientation and specific value performances. It can provide a theoretical basis for developing and implementing the information technology curriculum. Moreover, understanding the attributes, core concepts, logical structure, thinking and expression of information technology disciplines can provide a clearer understanding of the discipline's ontological value and educational value.

Explaining curriculum values is an essential first step when constructing an appropriate curriculum. The information technology curriculum value orientation has changed from the professional orientation to the application orientation, and now it has returned to the professional orientation in Britain. This reflects a general trend in the value orientation of the curriculum with social, cultural and economic benefits. Value orientation and specific value performances of Computing curriculum standards are to reflect and present the current curriculum and education values in order to meet the current social and personal needs. The result of integrating computer science, information technology, and digital literacy in the Computing curriculum is that computer science is often forgotten or ignored, leading to the teaching of information technology courses toward "how to use office software" rather than knowledge that can support students' future lives [41]. It combines techniques and methods for solving problems and advancing knowledge (such as abstraction and logical reasoning), and it has a unique computational thinking that distinguishes it from other disciplines. As an essential course for students' future development and learning, the value of a long-term future-oriented information technology curriculum needs to be considered. The curriculum has evolved from a technology-based to a competency-based approach, with an emphasis on innovation, creativity and digital literacy. It is necessary to dialectically view the pros and cons of reforming information technology curriculum standards and reasonably recognize the value orientations of its existence.

The participation of government, schools, social institutions and individuals as stakeholders play critical roles in the value reform of curriculum standards. The British government first supported the development of the British information technology curriculum. In the preparation and formulation of curriculum standards, the Britain Department for Education (DfE) conducts a comprehensive review of the entire national curriculum and compiles subject content for each subject. In response to changes in ICT curriculum standards, the DfE specifically invited the British Computer Society (BCS) and the Royal Academy of Engineering to conduct extensive consultations, coordinate with stakeholders and compile computing curriculum standards. The formulation process of curriculum standards shows the trust and collaboration between each other to a certain extent. In addition to the participation of the above two institutions, many people support the development and changes in the information technology curriculum. For example, the Computing at School working group (CAS) has become one of the most influential and dynamic organizations of the BCS. Designed to support teachers and address the challenge of declining computing in UK schools, it has played a critical role in the curriculum reform process in England [5,8]. The realization of the educational vision requires a renewal of the goals' learning and the ways in which learning takes place. Stakeholders' reactions to curriculum change are shaped by their social context [34]. After experiencing the collision and integration of various viewpoints, curriculum value orientation and specific value performances are produced and completed the conducive curriculum mission of serving society and students, as well as meeting their needs. In addition, the participation of all parties in the decision-making of curriculum standards can better balance the interests of all parties and is an important means to achieve equality in the curriculum.

In the context of curriculum standard changes, it was found that students' learning content has shifted from the emphasis on the value of process and skills to the value of professional knowledge, from emphasizing interdisciplinary themes to emphasizing subject knowledge. The realization of the educational vision requires the renewal of learning objectives and learning methods. The current curriculum reform trend establishes the link between learning in the present and a productive life in the future. The similarities and uniqueness of curriculum reform across different countries reflect the broader complexity

of curriculum reform and the intersection of different forces. This involves the interplay of international trends (such as globalization and international student assessments) and local influences (such as what knowledge and abilities are most valuable in society and necessary to prepare for the future) [34]. The British curriculum emphasizes learning to support students' future lives. Through computing education, students can acquire 'powerful knowledge' that enables them to become informed and active participants in our increasingly digital society [43]. In a digital society, every citizen needs to have digital literacy to play a role in the digital society. Students can use different resources and tools to innovate in plugged learning methods. Especially both before and during the coronavirus pandemic, schools have demonstrated their ability to use technology to try new things [4]. The way students learn is not only through office software operations and simple web searches but also by using tools such as Scratch and Raspberry Pi for programming and creative project learning. In addition, unplugged activities take an approach to exposing the student to the ideas of computer science without using computers [44]. This is particularly beneficial in situations where access to computer equipment is limited. Teachers should also consider students' prior knowledge when choosing unplugged activities.

Reform of curriculum standards for teachers' teaching can actively recognize and bring opportunities and challenges. Particular emphasis is placed on the importance and practicality of teacher recruitment and in-service training in curriculum and qualification reform, especially the need to provide effective pedagogic methods for teaching computing [45]. Factors such as high cost, the uncertainty of results, and risk aversion of stakeholders also bring additional obstacles to the initiation and realization of curriculum reform [34]. Compared with ICT curriculum standards, the length and description of Computing curriculum standards are reduced, which adds autonomy to teachers' teaching. Teachers can decide how to teach knowledge in subject content more effectively. The role of curriculum standards is no longer to tell teachers what and how to teach but to give teachers and schools greater freedom in curriculum design, evaluation, and development. The implementation of curriculum standards raises teachers' professional standards to a higher level. Facing current opportunities and challenges, training new teachers is not enough [5]. More training and professional development need to be provided to teachers [46,47] and to develop their confidence in computing pedagogical skills. Teachers are feeling the lack of teaching computing subject knowledge, ability and resources [48]. Some teachers question whether the programming teaching proposed in the standard can attract students' interest in learning and successfully improve students' learning abilities. England's secondary schools are facing a severe shortage of computing specialist teachers and this is also an issue in primary schools where current teachers are asked to teach a subject that they are unfamiliar with. Curriculum reform requires significant investment in the training and capacity building of the teaching force, acceptance of new curricula, and development of new teaching methods and material resources [41]. To this end, different organizations and institutions have provided assistance for teacher training and teaching [49]. The Computing at School working group supports teachers to learn computer science by setting up a computer science teaching excellence network and keeps them carrying out relevant teaching in the classroom. Moreover, universities are excellent resources for teachers seeking to increase their subject knowledge [50] and those in Britain have shown a great willingness to support teachers in teaching. In addition, it will convince teachers that technology will work in the classroom by publishing new digital, data and technology standards that set out the core technologies in all schools [4]. Teachers can help students realize the benefits and power of access to information technology, the lack of which may disadvantage specific groups or individuals in society, and guide students to reflect on the moral and cultural values of computing courses. Teachers should actively consider whether any groups of students are excluded from instructional programs and activities. For example, courses based on mobile phone or computer games may disadvantage students who do not have access to such technology at home. Instructional design should avoid stereotypes related to information technology and computing as a domain of male learning, and should

also actively reflect the contributions of female practitioners. Teachers should focus on assessment, with a focus on balancing the knowledge and skills, and generic competencies identified in the curriculum. Formative assessments are also needed for early identification of misconceptions.

Existing research about the value and function of information technology curriculum needs to be enriched and developed, and it is required to explore the value orientation, knowledge content selection, implementation and existing problems of curriculum reform trends and content in detail. Future research needs to focus on the value and function of computer science, information technology, and digital literacy in different educational contexts and disciplines to achieve their most effective role. This research makes full use of curriculum value theory, combined with the analysis of information technology curriculum value system, finds problems in curriculum reform and improves theoretical information technology curriculum value system. Through a comparative research perspective, we pay attention to the current situation before and after the reform of information technology curriculum standards in British primary and secondary schools and the problems of the information technology curriculum at the theoretical and practical levels. The shortcoming of this research is that it did not collect data from students in British primary and secondary schools, and it could not obtain a more comprehensive implementation status of the British Computing curriculum. Due to the limitation of the research conditions, we collected data from experts and teachers but no sample survey of students who are in British primary and secondary schools. When analyzing the value and implementation status of the information technology curriculum, the research lacks from students standpoint. Questionnaires or interviews are needed to further investigate students to reflect on the impact of information technology courses on students' development values.

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