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## Challenge of Teaching Genetics at Early Stage

Edwards Willey, Fuzhou Wang

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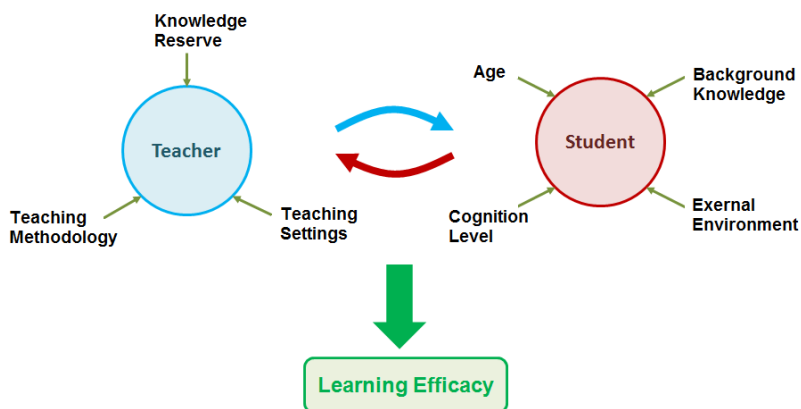
*“I cannot teach anybody anything. I can only make them think.”*

*– Socrates*

AS a part of early science education, biogenetics is one of the critical components. Usually, the course is taught at the middle school at the earliest (Committee on the Science of Children Birth to Age 8, 2015). There may be specific difficulties for adolescent students who are first exposed to genetics knowledge, from cognition to knowledge reserve. In addition, understanding its basic concepts may require the lecturer to adopt certain methods and skills (Hirsh et al., 2020). Due to the abstract nature of genetics, this is more challenging for students of this age.

As far as genetics teaching is concerned, it is challenging for higher professional academic education (such as medical students and dental students, etc.) (Shirani Bidabadi et al., 2016). Of course, this is especially true for middle and high school students. Kılıç Mocan (2021) observed the understanding of basic genetics knowledge of high school students in his school through an interview. It turned out that many students are unfamiliar with its concepts and fail to clarify the relationship between the basic concepts, causing mutual confusion. This result is understandable. This is true among beginners and happens in the early stages of learning among professional students (Dudliceck et al., 2004; Monsen, 1999; Telner et al., 2008).

Human cognition of things is a gradual process (Sanders, 2013). Age is one of the crucial factors affecting cognition (National Research Council (US) Panel to Review the Status of Basic Research on School-Age Children, 1984). We cannot overcome the influence of age on the perception of things. However, under the same conditions and background, the methods of acquiring knowledge can be very different, and their results will also vary greatly. Of course, this difference in learning efficiency due to methodological differences is exceptionally related to the person's knowledge level, the teaching methods they use, and the teaching conditions their institution provides (Değirmencioğlu, 2021; Jungert & Rosander, 2010; Sharp et al., 2016). For



**Figure 1. Teacher-Student Interactive Relationship.**

example, suppose a highly knowledgeable teacher has a blunt and uninspired teaching method and only instills knowledge points into the students or lets them memorize by rote. In that case, one can imagine how their teaching effect will be.

In the same way, a teacher may lack some knowledge reserves, but his teaching methods can arouse students' sympathy and interest. This undoubtedly enables students to grasp the concepts and relationships among their learned points quickly. Therefore, regardless of the subject, students' cognition and mastery of knowledge result from a number of factors that comprehensively function. Of course, the teaching of genetics is with no exception. Teaching is ultimately a comprehensive result of the software and hardware interaction of various aspects such as students, teachers, and the environment (**Figure 1**).

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# Scientific Evaluation of Student Assignments at Basic Education Level

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*“A patient pursuit of facts, and cautious combination and comparison of them, is the drudgery to which man is subjected by his Maker, if he wishes to attain sure knowledge.”*

*- Thomas Jefferson*

**A**SSIGNMENTS are effective means to assess students’ learning results. Students can consolidate their knowledge through school assignments and use their knowledge to solve problems. Assignments include in-class assignments and after-class assignments. In-class assignments are not only a basic component of classroom teaching, but also assessment of students’ mastery of knowledge. After-class assignments are complementary to students’ classroom learning and of equal value to in-class assignments. At basic education levels, proper assignment loads are necessary. Students’ learning lacks assessment without assignments; Learning without assessment is unacceptable and even brings disastrous consequences (Bai, 2010).

On the other hand, emphasizing the necessity of assignments does not mean that the role of assignments should be over exaggerated, which will cause students excessive assignment loads. Numerous studies have shown that at present, students’ assignment burden is too heavy in some countries and regions, especially in Southeast Asia (OECD, 2019). Excessive assignment loads deprive students of time for other activities and hinder students’ healthy development.

Therefore, we should evaluate the role of student assignments in a scientific way to avoid the simple “one size fits all” approach. Liu and Hudang (2021) discussed how to examine students’ assignments at basic education levels from specific perspective. They examined different explanations of academic burden, and analyzed objective assessment indexes and factors influencing students’ academic burden. From a humanistic stance, this paper puts

forward some pertinent views and suggestions on how to address the issue of student academic burden reasonably.

To sum up, at basic education levels, school assignments, as an important component of teaching activity, are extensions of and supplements to classroom teaching, and are learning tasks to be fulfilled by students independently (Xiao, 2014). Thus, it is essential to examine assignment design scientifically to improve the effectiveness of assignments. When giving full play to the role of school assignments in student learning, we should also standardize assignment design to avoid excessive schoolwork burden.

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# What do Students Really Understand? Secondary Education Students' Conceptions of Genetics

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**Abstract:** *Individuals with a secondary education should have a knowledge level sufficient to make sense of what they read or hear about genetics, and they should be able to think scientifically in evaluation and decision-making processes. The purpose of this study is to identify the basic understanding of secondary education students about genetic concepts and the reasons for the difficulty of learning and teaching genetics. Semi-structured interviews that include student drawings have been conducted with 24 students to gain a comprehensive perspective on secondary education students' understanding of the basic concepts of genetics. The answers given by the students to the interview questions and their drawings have been analyzed with content analysis. Qualitative data analyzed with a holistic point of view were collected and evaluated under the categories of 'DNA, gene and chromosome' and 'Cell divisions and heredity relationship.' As a general result, it has been found that students have inaccurate and inconsistent information about the basic concepts of genetics, have difficulties in establishing relationships between these concepts, and cannot fully understand and explain the processes underlying genetic events. It has been observed that various factors have an effect on this result. It will be possible to support students to develop a more accurate understanding of genetic concepts and issues by working on the weaknesses in genetics teaching, providing an enriched teaching environment with current teaching methods and materials, and moving away from rote learning.*

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## **Introduction**

**W**ITH the discovery of the molecular structure of DNA, genetics has become one of the most important subjects in biotechnological research that accelerated revolutionary developments in many applied fields such as medicine, agriculture and animal husbandry, and especially industry. Today, hereditary diseases can be diagnosed prenatally, new drugs and vaccines can be developed, cancer can be diagnosed and effectively treated at much earlier stages, compatible organ transplants can be made, and efficient, durable, and nutritious food products can be produced with gene technologies. While discoveries in the field of genetics provided new insights into some fundamental problems of evolution, the origin of life, and the structure of living things (Okebukola, 1990), they also made significant contributions to people's understanding of the living environment, including themselves.

Rapid developments in gene technologies bring along some social, economic, and ethical questions. According to Marbach-Ad (2001), members of a society need to receive an effective education to understand and answer these questions. Genetics education plays a major role in raising knowledgeable and responsible individuals, both to prevent scientific developments from being interrupted by unnecessary concerns, and to protect human rights and ensure environmental awareness. Learning about genetics is considered a very important part of scientific literacy, which has a decisive role in the scientific thinking and decision-making processes of citizens (Boerwinkel et al., 2017; Haskel-Ittah et al., 2020). With the increasing importance of genetics in daily life, it is emphasized that more attention should be given to issues related to genetics in education systems (Hott et al., 2002) and genetic literacy should become more widespread (Kawasaki et al., 2021). In the studies conducted by Lewis et al. (2000a; 2000b; 2000c), it is stated that new developments and research in the field of genetics are the subjects of news every day, and societies should be scientifically literate in genetics to understand developments in the field of medicine. It is argued that individuals with a secondary education have a knowledge level sufficient to make sense of what they read or hear about genetics and should be able to participate in the decision-making processes.

The biology subjects that students have difficulty in understanding were first researched by Johnstone and Mahmoud in 1980 and genetics was identified as one of the subjects that students have the most difficulty in understanding. Studies conducted in the following years have revealed that genetics is among the subjects that students have difficulty in understanding (Bahar et al., 1999; Banet & Ayuso, 2000; Duncan & Reiser, 2007; Finley et al., 1982; Kablan, 2004; Kılıç & Sağlam, 2014; Kindfield, 1991; Marbach-Ad & Stavy, 2000; Rotbain et al., 2005; Stewart, 1982; Tekkaya et al., 2001). Dorji et al. (2017) report that the number of studies showing that high school students graduate with extremely weak and inadequate knowledge in the field of genetics is increasing.

Evaluating the studies in genetics education, Knippels et al. (2005) list the reasons for these difficulties as the field-specific terminology, the mathematical content in Mendelian genetics, cellular processes in genetics, abstract genetic concepts, and the

complex nature of genetics. According to Duncan and Reiser (2007), another reason that students have difficulty in understanding genetics is that genetic events are invisible and inaccessible. Most of the genetic concepts are classified as theoretical concepts because they are hypothetical and imaginary concepts. Therefore, students need to be able to think hypothetically to understand theoretical genetic concepts (Baker & Lawson, 2001). In addition, the necessity of logical thinking that is at the core of high-level thinking skills in order to understand genetic concepts is another reason that explains the difficulty in understanding genetics (Banet & Ayuso, 2000). Another reason that genetics topics are difficult to learn and teach is that these topics involve concepts (such as genes, proteins, cells, tissues, organs) that belong to different levels (macro, micro, and molecular levels) of a biological organism. To understand the processes underlying genetic phenomena, students need to be able to integrate these different levels into the bigger picture so that they can understand genetics as a whole (Bahar et al., 1999; Duncan & Reiser, 2007; Marbach-Ad & Stavy, 2000). According to Rotbain et al. (2005), difficulties in understanding genetics increase especially with molecular level concepts, because teachers and books use chemical formulas and abstract and complex figures to demonstrate the structure of molecules. In addition, the similarity of genetic terms in both spelling and pronunciation (Bahar et al., 1999) and the synonymous words in genetic terminology (Pearson & Hughes, 1988a) make it difficult for students to understand genetics by making them confuse these concepts with each other.

After the teaching of genetics, students have information about related concepts, but they often misunderstand these concepts and related issues. This is because knowledge is necessary but not sufficient to understand the subject. To understand the subject, connections must be made between information and relationships must be comprehended. As explained by Ausubel (1968), meaningful learning occurs when students consciously associate new knowledge with related concepts and processes (Okebukola, 1990; Wandersee, 1985). If the new information conflicts with the existing knowledge or if the students lack the necessary knowledge to understand new information, they have difficulty in comprehending the subject. Learning the concepts incorrectly or incompletely also negatively affects learning other related concepts. In particular, the correct understanding of some concepts is effective in correctly learning many related subjects on which these concepts are based (Kılıç et al., 2009). The information should be used to solve new problems and to explain new situations. In some cases, students can solve problems without knowing the meaning of the concepts or knowing why, by using various personal processing methods (Banet & Ayuso, 2000; Hackling & Treagust, 1984). However, the fact that students can answer the questions correctly does not mean that they have sufficient conceptual understanding to solve these problems (Orcajo & Aznar, 2005). The student who understands should not only have a valid scientific explanation but also be able to explain the reasons for it. To evaluate students' understanding of concepts, it is important to determine not only the level of knowledge they have but also the reasons on which they base this knowledge. Stewart and Dale (1989) state that students who understand genetics should be able to explain the mechanisms underlying genetics. As stated above, a correct understanding of the basic con-

cepts in genetics will enable not only understanding the interaction between these concepts but also explaining the mechanisms underlying genetic events. Thus, it will be possible for students to think scientifically about genetics in their evaluation and decision-making processes.

By identifying the knowledge level of students about the basic concepts of genetics and how they explain this knowledge, the reasons for the difficulty in learning genetics will become more understandable. In this way, effective road maps can be made for teaching genetics. This research, which aims to reveal information about possible weaknesses and deficiencies in the teaching of genetics, was carried out with secondary education students. In our country, secondary education comprises the high school period with duration of 4 years. Starting from the 9th grade and successfully completing the 12th grade, students become high school graduates. According to the Turkish education system, high schools are secondary education institutions that prepare students who have completed primary education for higher education. Secondary education students are at a cognitively sufficient level to understand the abstract content of genetics, make logical inferences, and establish cause-effect relationships for the solution of problems. The fact that detailed teaching of genetic concepts and events is included in secondary education programs has also been effective in determining the target group of this study. Also, previous research suggests that high school students do not have enough domain-specific knowledge to adequately explain complex genetic phenomena. In this study, the framework of which was drawn for these reasons, the goal is to identify the basic understanding level of secondary education students about genetic concepts. It is aimed to develop an understanding of the reasons for students' knowledge, deficiencies, and misunderstandings by identifying them, and it is expected to contribute to filling the gaps remaining in genetics education.

## **Method**

Consistent with the theoretical framework and the aim of the research that focus on student's in-depth understandings of the genetics concepts, this research was conducted in the interpretive paradigm (Cohen, Manion, & Morrison 2000). The data were generated through detailed, non-directive interviews including student drawings.

Semi-structured interviews were conducted with 24 students to gain a comprehensive perspective on secondary education students' understanding of the basic concepts of genetics. The participating students study at the 9th, 10th, 11th, and 12th grade levels of different secondary education institutions. The reason for selecting students from each grade level for the interviews is to demonstrate the understanding of the students regarding the related concepts and topics and to determine the stages at which conceptual difficulties occur. While determining the number of students to be interviewed, the repeat answers to the interview questions were taken into account, and it was decided that a sufficient number of data were reached at a certain point.

Information on the demographic characteristics of the students participating in the study is given in **Table 1**.

**Table 1. Demographic Characteristics of the Study Group.**

Demographic Characteristics	f	%	
Gender	Female	15	62.5
	Male	9	37.5
Age (yr)	16	5	20,8
	17	9	37,5
	18	6	25,0
	19	4	16,7
Grade Level	9th	5	20,8
	10th	6	25,0
	11th	7	29,2
	12th	6	25,0
Total	24	100,0	

The pre-knowledge of the students participating in the study on genetics is limited to the scope of the primary school curriculum, and they have not had an extra-curricular learning process on genetics. Considering the secondary education curriculum, subjects related to genetics are primarily taught in the 9th grade within the scope of the “Life Science Biology” unit, according to the Biology Curriculum of the Ministry of National Education. Genetic subjects taught in 10th grades are under the unit titles of “Cell Divisions” and “General Principles of Heredity”. There is no unit on genetics in 11th grade. In the 12th grade, genetics is taught in the unit “From Gene to Protein”, which includes the topics “Discovery and Importance of Nucleic Acids” and “Genetic Code and Protein Synthesis”.

A literature review of previous research on the subject was used in the preparation of the interview form (Banet & Ayuso, 2000; Baker & Lawson, 2001; Johnson & Stewart, 2002; Lewis et al., 2000a; 2000b; Lewis & Wood-Robinson, 2000; Marbach-Ad & Stavy, 2000; Venville & Treagust, 1998; Venville et al., 2005; Wood-Robinson et al., 2000). The translation and adaptation of the questions deemed appropriate for the research were made by biology education experts and items related to the basic concepts of genetics were added to the interview form. As a result, a preliminary interview form consisting of 10 items was created. Expert opinion was taken to ensure the validity of the interview form. The preliminary interview was applied to 2 secondary education students as a pilot study and 1 more question was added to the interview form in line with the data obtained. The questions prepared for the interview were supported with alternative questions and probes, and it was decided in which possible order the questions would be asked.

The interview form has two parts: The first part consists of questions about the basic concepts of genetics, their functions, and relationships. And the second part consists of questions in which students are asked to make various drawings related to these

concepts. The questions in the interview form are aimed at getting the opinions of the students about the relations between the concepts of gene, DNA, chromosome, genetic information and heredity, and gene-DNA, gene-chromosome, cell divisions-heredity. Finally, in the interviews, the students were asked about the situations in which they had difficulty in learning these subjects, and they were asked to explain the reasons. All of the interviews with the students were carried out by the researcher in a semi-structured way. The interviews lasted approximately 30 minutes.

Interview protocols were prepared by transcribing the data, and then the statements in the protocols were arranged. Since non-verbal information is also effective in interpreting the data, non-verbal expressions were also written down. Mayring (2002) and McLellan et al. (2003) recommend transcription rules while preparing protocols, which were taken into account in this study. The rules suggested by Gropengiesser (2001) were also taken into account while making some adjustments so that there would be no change in the content of statements of the students. After the student expressions that emerged in the interviews were organized, the data were analyzed with content analysis. Qualitative data analyzed with a holistic perspective were gathered under categories and evaluated.

## **Results**

As a result of the students' answers to the interview questions and the analysis of their drawings, the findings were evaluated under two main categories. The first of these relations is DNA, gene, and chromosome, and the second is cell divisions and heredity.

It was seen that students used these concepts interchangeably in their drawings and answers to the questions about the concepts of 'DNA, gene and chromosome' and their locations, functions, and relationships, they could not distinguish them from each other well, and they also had some incomplete and incorrect information. Some direct quotations from student opinions are given below.

*Interviewer: What is the reason for people's resemblance to their parents?*

*Student 8: Because the chromosomes are carried by the gametes, that is, one comes from the mother and one comes from the father, it depends on the characteristics of the mother and father, whether [these features] are dominant or not. (Male, age: 19 yr, 12th grade)*

Student number 8 states that genetic characteristics are transferred from the parents to the offspring with chromosomes and that the chromosomes are carried by the gametes. However, in the follow-up questions, it was found that the student had the view that chromosomes are only found in gametes. In another statement, student number 11 seems to have a similar view that genes are only found in gametes.

*Interviewer: What can you say about genes? For example, where are genes located?*

*Student 11: [Genes] [are] found in the gametes. (Female, age: 17 yr, 10th grade)*

It is seen that students have difficulty in explaining where genes are located in the body. It is understood that about 33% of students believe that only gametes contain genes or genetic material.

*Interviewer: Where are genes located in our body?*

*Student 21: Genes are found in DNA cells, in every cell in our body. The genes in reproductive cells already carry our hereditary characteristics. For transmission, they [reproductive cells] are used. (Female, age: 17 yr, 11th grade)*

Although student number 21 states that genes are found in all cells, she thinks that the genes that carry our hereditary characteristics are found only in the gametes and that gene transfer can take place in this way. It is also seen that the same student has a wrong concept about "DNA cells."

*Interviewer: Where is the genetic information that determines eye color found?*

*Student 5: Our eye color [...] is found in our own gamete so that it can be passed on to our child. After all, you cannot take something from the eye and send it to the sperm cell. (Male, age: 17 yr, 10th grade)*

*Interviewer: There are genes that determine eye color; I gave eye color as an example, where do you think those genes are found?*

*Student 15: [The genes that determine eye color] are either recessive or dominant in X and Y. (Female, age: 16 yr, 9th grade)*

Students of number 5 and number 15 are of the opinion that genes are only found in the gametes or the sex chromosomes. This situation shows that students have difficulty in distinguishing heredity and reproduction processes from each other. Another remarkable answer to this question was given by student number 20:

*Interviewer: There are genes that determine eye color. In which cell are these genes found?*

*Student 20: It could be the brain. After all, everything is under brain's control. (Female, age: 17 yr, 11th grade)*

It is understood that there are students who think that genes are found only in the gametes, as well as those who think that they are found in the sex chromosomes, in the cells of the related organ, or the brain.

Almost all of the interviewed students (91.6%) gave similar answers to the question, "Where are the sex chromosomes found?"

*Student 3: It's in our gametes. (Male, age: 16 yr, 9th grade)*

*Student 5: The male sex cell is found in the sperm or [female germ cell] egg. (Male, age: 17 yr, 10th grade)*

*Student 14: It can be in the cells of the reproductive organs. I don't know exactly, but all of them have it, some of them may not be used or they may be only in the genitals. I'm not sure. (Female, age: 18 yr, 12th grade)*

*Student 17: In the ovaries and testicles. (Female, age: 17 yr, 11th grade)*

Some direct quotations from the answers given to the interview questions in which students' understandings of the relationships between the concepts of gene, DNA, and chromosomes are given below:

*Interviewer: Is there a relationship between gene and DNA?*

*Student 17: There is. Genes are ultimately part of DNA, or DNA is part of a gene. (Female, age: 17 yr, 11th grade)*

*Interviewer: Where are the chromosomes located?*

*Student 9: There are chromosomes in DNA, and there are genes in chromosomes. (Female, age: 17 yr, 10th grade)*

*Interviewer: Where are genes found?*

*Student 7: Were genes inside our chromosomes?*

*Interviewer: Can you explain the relationship between gene and chromosome?*

*Student 7: Was the chromosome also in the gene? (Female, age: 18 yr, 11th grade)*

*Interviewer: Where are the chromosomes located?*

*Student 12: Chromosomes are found in DNA. (Male, age: 17 yr, 10th grade)*

*Interviewer: What is the relationship between gene and DNA?*

*Student 15: DNA, chromosome, gene, where and how [they are found] is a bit complicated (Female, age: 16 yr, 9th grade)*

It is striking that the students have complex ideas about the concepts of genes, DNA, and chromosomes, especially about their location, and they are not sure of their knowledge. Among the reasons for this is the students' evaluation of these concepts as independent constructs. It is understood that due to the different characteristics of genes, DNA and chromosomes, students have difficulty in understanding that these three different concepts basically perform the same tasks.

The data evaluated within the scope of 'cell divisions and heredity relationship', which emerged as another category after the analysis of the answers given by the students to the interview questions and their drawings, revealed that students have confusion about the concepts and that they cannot establish the relationship between cell divi-

sions and heredity correctly. Some direct quotations from student opinions are given below.

*Interviewer: You have a wide variety of cells; for example, your eye cell, your cheek cell, your liver cell, etc. What do you think is the genetic information in these cells?*

*Student 15: It is different. It is naturally different since they have different functions. (Female, age: 16 yr, 9th grade)*

*Interviewer: Do you think the genetic information in your eye cell and liver cell is the same or different?*

*Student 20: It is different. After all, the eye is for seeing, and the liver has different functions. They are different because they have different functions. (Female, age: 17 yr, 11th grade)*

In another question asked with the aim of understanding what the students know about the characteristics of genetic information, it was found that the students have wrong ideas. According to this, students think that cells with different functions, structures, or shapes carry different genes. These results are due to teaching mitosis without associating it with heredity. It is understood that the students failed to comprehend that new cells are formed by mitosis during the growth and development of the individual and thus have the same genes as the zygote. Another result that emerged from the students' answers is that the idea that there is a relationship between meiosis and heredity, but that mitosis does not have any relationship with heredity, is dominant.

*Interviewer: According to what you said, meiosis has a role in heredity, so what is its function? What does it do, what is its function?*

*Student 14: It enables the creation of new gametes. Variety is provided [with] crossing over (...).*

*Interviewer: So, does mitosis have an effect or importance in heredity?*

*Student 14: I don't think so. (Female, age: 18 yr, 12th grade)*

*Interviewer: Does mitosis have any effect on or a role in heredity?*

*Student 6: I think mitosis has no effect. Mitosis has nothing to do with heredity because it is responsible for the regeneration and proliferation of tissues. (Female, age: 16yr, 9th grade)*

Another answer that draws attention among the answers given to the question asked with the aim of revealing what the students know about the relationship between heredity and cell divisions belongs to student number 5. In this quotation, it is seen that the student's knowledge about the characteristics of cell divisions is wrong.

*Student 5: Meiosis causes the gametes to be halved. In mitosis, on the other hand, it prevents doubling. (Male, age: 17 yr, 10th grade)*

In some quotations, it is seen that students do not know the characteristics of mitosis and meiosis, and they cannot establish their relationship with heredity.

After the questions were completed in the interviews, the students were asked their opinions about why they had difficulty in learning these concepts and related subjects or why they were confused. The students' opinions on this subject give clues about the reasons for the incomplete and incorrect information they have about the concepts and issues related to genetics.

*Student 1: We cannot visualize [concepts], I can say that. The fact that these concepts are not displayed visually on the figures causes confusion. In other words, I think it would be much more helpful if the chromatid was explained to us, what a chromosome is, how meiosis happens, step by step, by drawing figures. So I think they should be visualized. We memorize the information, we write it down during exams, and then we forget it. (Male, age: 18 yr, 11th grade)*

*Student 2: [These concepts] are not clearly explained visually. What is a chromosome, what is a chromatid, these are expressed in one sentence, but the concepts are also very close to each other. Knowing the answer to the questions is important in the exam. Chromosome, chromatid, chromatin, they don't matter. And even if you want to study by yourself, the textbooks are not sufficient. Because it is possible to learn it wrong from those sources because the sources are not always very reliable either. When you learn wrong, then it cannot be corrected. It is such a subject that genetics should be explained by someone who knows it very well and has a good command of the subject, you cannot do it by yourself. Other subjects are not so complicated. Genetics is a bit more complicated in terms of concepts compared to other subjects. Other subjects can be understood if you go and study from the source yourself, but genetics cannot be understood. (Female, age: 18 yr, 11th grade)*

*Student 5: For example, you just asked very good questions, 'What is a gene?' For example, I did not understand the definition of it exactly; maybe it is because I still do not understand the subject. 'What is a chromosome?', just as far as I know, [...] there is a line called chromosome big gene, I memorized that to learn the subject. I don't think the concepts were taught well, or they weren't received. In other words, I did not learn the concepts well, we need to start from scratch and learn, I think it is explained in a way as if we already know everything. Frankly, I haven't studied this subject very often. The concepts should have been taught first, 'what is a*

*gene', 'what is a chromosome', then it had to be taught in-depth.  
(Male, age: 17 yr, 10th grade)*

*Student 3: There is confusion due to drawings and shapes. (Male,  
age: 16 yr, 9th grade)*

*Student 14: It may be because there are many foreign words. Some  
people have a different point of view, they don't like biology, but I  
think it's because there are a lot of foreign words and because it  
requires memorization [because]. And it's complicated, I mean,  
they are all so similar to each other. (Female, age: 18 yr, 12th  
grade)*

*Interviewer: Are the words similar or their definitions?*

*Student 14: Words. For example, it is not the same as in Turkish,  
that is, when you add a letter, it is conjugated, but not in biology.  
When you add a letter, it can mean an entirely different thing.  
That's why. (Female, age: 18 yr, 12th grade)*

*Student 15: The reason they are confused with each other is be-  
cause their meanings are similar. (Female, age: 16 yr, 9th grade)*

As a result of the interviews conducted to obtain information about the students' misunderstandings about the basic concepts in genetics, it was concluded that a significant portion of the students has incorrect and inconsistent views about the basic concepts of genetics. It is seen that students have some knowledge about the phenomena, but they cannot form conceptual integrity with these phenomena.

## **Conclusion and Discussion**

In this study, which aims to reveal the knowledge level of secondary education students about genetics and the source of this information, the data obtained from the interviews with the students were examined. As a general result, it has been found that students have inaccurate and inconsistent information about the basic concepts of genetics, have difficulties in establishing relationships between these concepts, and cannot fully understand and explain the processes underlying genetic events. These results are similar to the results of many studies in the literature (Bahar et al., 1999; Banet & Ayuso, 2000; Dorji, Tshering, & Dorji, 2017; Duncan & Reiser, 2007; Finley et al., 1982; Haskel-Ittah, Duncan, Vazquez-Ben, & Yarden, 2020; Stewart, 1982; Kindfield, 1991; Marbach-Ad & Stavy, 2000; Rotbain et al., 2005; Tekkaya et al., 2001).

The findings obtained from the interviews revealed that some students confuse the concepts of gene, DNA, and chromosome with each other and therefore cannot explain the relationships between the concepts correctly. For example, it was found that some of the students think that DNA consists of chromosomes or that chromosomes are found in DNA. Similarly, Lewis et al. (2000c) found that the concepts of gene and

chromosome are frequently used interchangeably. In another study, it is stated that students have a lot of confusion about the relationships between the concepts of gene, DNA and chromosomes (Wood-Robinson et al., 2000). Another issue that the students in the study were confused about is the location of the genes. Findings from interview questions towards the knowledge that genes that determine any trait are found in all cells showed that if students know the correct answer, then they also know the reason for the correct answer. However, when the wrong answers were examined, it was found that the rate of students who had the idea that genes are only found in the gametes was high. In another study with similar findings, Lewis et al. (2000c) concluded that a large number of students believe that only certain cells, especially those in the reproductive system, contain genetic information. In addition, the answers given to the related questions revealed that some students think that the gene that determines any trait is found only in the cell, tissue, or organ with that trait. These students believe that each cell contains only its own unique genes. In another study, it was found that most of the students believe that each cell type has different genes (Hackling and Treagust, 1984). Many students in this study stated that cells carry different genetic information according to their functions. Similarly, according to another research result, students think that cells contain only the genetic information they need to perform their functions (Lewis et al., 2000a). In addition, in the study, it was found that a very large portion of the students think that the sex chromosomes are only found in the gametes or reproductive organs. According to the results of other studies that have similar results with this finding, students think that only the gametes carry chromosomes and that these chromosomes are either X or Y (Lewis et al., 2000b; Chattopadhyay, 2005). It was observed that almost all of the students correctly answered the questions regarding the sex chromosomes, X and Y chromosomes, determining gender. However, it was found that the students did not have any other information about the functions of chromosomes, so when chromosomes were discussed, they only thought about sex chromosomes. Lewis and Wood-Robinson (2000) in their research, in response to the question "Why are chromosomes important?" they mostly received the answer, "it determines the gender." In connection with this finding, it was understood that the students were not aware of the presence of both sex chromosomes and body chromosomes in all cells. It has been observed that students are very successful in solving genetic problems related to the number of chromosomes in situations that require mathematical operations. However, it has been found that they have difficulties in explaining how the number of chromosomes in cells is regulated. In addition, it was found that the students generally answered the questions about the characteristics of mitosis and meiosis correctly, but were unsuccessful in questions related to mitosis and meiosis.

These findings, which reveal the views of the students in the study about genetic concepts, show that the students have incorrect and missing information about the structure and location of these concepts and the relationships between the concepts. It has been observed that various factors have an effect on this result. One of these factors is the teaching of genetic concepts. Since the concepts are abstract and imaginary concepts, students have difficulty in understanding and they cannot achieve meaningful

learning because they cannot establish a relationship between the concepts. It is seen that there is a need for more visual material in teaching genetic concepts and the concretization of abstract concepts. The results obtained from the interviews showed that as the grade level increases, the students use more and more diverse concepts related to genetics. However, it was also observed that the students had difficulty in providing in-depth explanations. In addition, another result obtained from the interviews is that the students are not sure of the information they have. It is understood that this situation arises from the fact that students have incomplete and inconsistent information about basic concepts and subjects. This result shows that teaching basic concepts independently from each other makes it difficult for students to establish relationships between genetic events and concepts. At this point, it is considered important to emphasize the relationships between genetic concepts in teaching genetic events and processes. As a result, due to the lack of teaching about the abstract content of genetic concepts and the complex nature of genetic events, students have difficulty in establishing relationships between these concepts and cannot demonstrate an adequate understanding.

It has been found that another reason that students have difficulties in understanding genetic concepts is genetic terminology (Pearson & Hughes, 1988a). Genetics has its own technical vocabulary. In parallel with new developments, new terms are added to the genetic terminology, which includes many synonymous concepts and words that are similar in spelling, or some terms are no longer used. For these reasons, genetic terms emerge as a factor that makes it difficult for students to understand genetics. In the interviews, most of the students stated that the genetic concepts are foreign to them. In addition, the facts that the words are similar to each other and the meanings of the expressions are similar cause the students to get confused. In another study on genetics, the same result was emphasized and it was stated that similar words cause confusion (Bahar et al., 1999). On the other hand, the wrong or careless use of genetic concepts in textbooks and by teachers causes students to not fully understand these concepts. Pearson and Hughes (1988b), in their study, reviewed various textbooks and identified misused genetic concepts. The researchers stated that this result caused both students and teachers to experience confusion about genetic concepts. The fact that genetics contains a large number of foreign and similar terms or they are incorrectly expressed causes students to confuse genetic concepts and not to understand them fully.

Another result that emerged during the interviews was that the students had some knowledge about genetic concepts but could not explain the reason for this knowledge. This result reveals that students partially know the facts, concepts, and events related to genetics, but they cannot understand the processes underlying genetic events. It has been understood that one of the important factors leading to this result is the university entrance exam. In our country, the university entrance exam consists of multiple-choice questions and the low number of biology questions within the scope of the exam affects students' study approaches and learning processes. In the distribution of questions by subject over the past three years, an average of 4 out of 160 questions was about cell divisions and genetics. Because this number is low and students find genetics topics difficult, some students ignore subjects related to genetics. Learning about

genetics, which includes abstract concepts and complex relationships, requires more time and effort compared to other subjects. In this case, some students choose to learn genetics superficially and by rote memorization. In a study, it was stated that students tend to learn about genetics concepts separately, without establishing connections between them and structuring these concepts (Cavallo, 1996). However, learning genetic concepts by rote memorization results in students failing to use these concepts in different problem situations they encounter and also to explain the reasons for the knowledge they have.

The fact that some of the results obtained in the study are similar to the results of the relevant studies carried out many years ago (Banet & Ayuso, 2000; Chattopadhyay, 2005; Lewis et al., 2000a; Lewis et al., 2000b; Lewis & Wood-Robinson, 2000; Marbach-Ad & Stavy, 2000; Tekkaya et al., 2001) shows that the difficulties in the learning and teaching of genetic subjects and concepts continue to exist. At this point, it can be argued that an important contribution can be made by supporting teacher education in terms of current teaching approaches and the use of technological materials. In addition, updating the textbooks and source documents by enriching them with visual elements can be an effective solution. Considering that the invisible and inaccessible nature of genetic events is an obstacle to students' understanding, the need for a teaching environment supported by various animations and videos should be taken into account by teachers, education administrators, and curriculum developers. Since rote learning leads to unsuccessful results in understanding genetic concepts, it is also important for students to adopt a meaningful learning approach and to be guided in this direction.

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# Evaluation and Analysis of Student Academic Burden: A Global Perspective

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**Abstract:** Student academic burden exists to varying degrees throughout the world. To reach a comprehensive and unbiased understanding of the roles of academic burden, this paper explores academic burden from different viewpoints and summarizes existing assessment indexes for it. Factors correlated with student academic burden are examined and detailed evaluations on both its advantages and disadvantages are conducted. Some suggestions are proposed to better address this issue for the benefit of student healthy growth and development.

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## **Introduction**

**A**CADEMIC burden refers to the effect of schoolwork loads on students' physical and mental condition. International studies rarely mention the concept of academic burden. Instead, they examine the effects of weekly learning hours and homework loads from different angles, generating expressions similar to academic burden, such as academic burnout, academic pressure, academic anxiety and academic depression. In fact, academic burden exists worldwide and especially in Southeast Asian countries where, even at basic education levels, excessive academic burden created by entrance examinations for schools poses a serious problem. Existing research indicates that appropriate levels of academic burden can promote learning outcomes, while levels that are too high will lead to psychological and behavioral problems in students. Thus, scientific evaluation and analysis rather than biased comments are needed for a rational assessment of student workload. This paper uses a global perspective to examine different explanations of academic burden and summarize suggested assessment indexes. Variables at the level of students, families, teachers, and society that correlate with student academic burden are discussed and the benefits of appropriate academic burden and risks of excessive academic burden are fully analyzed. With a humanistic stance, we also put forward suggestions to rationalize student academic burden by focusing on the comprehensive development of individuals and optimizing teaching and learning methods.

## **Conceptual Analysis of Academic Burden**

The concept of 'academic burden' varies among different national education environments and systems. Research perspectives and materials of scholars similarly vary. In Southeast Asian countries such as China, Singapore, Japan and South Korea, where student learning pressure is typically intense, scholars mainly interpret academic burden as the stressful experience of students as they attempt to adapt to the current learning environment and the time and energy required by students for examinations and homework (Song & Yang, 2014). Similar expressions such as schoolwork burden, learning burden and student burden are also used.

In contrast, for Western countries, e.g., the United States, Britain, and Finland, in which 'happy learning' is advocated, scholars less commonly mention academic burden. Instead, scholars pay attention to the negative effects caused by homework and study, such as physical dysfunction, emotional fluctuation, anxiety, depression, negative and passive attitudes, personality disorders, confusion and declines in efficiencies. Thus, in the 1980s, researchers from Western countries, borrowing from the working world phrase 'job burnout', created expressions such as learning burnout, academic burnout, academic pressure and academic anxiety to describe the physical and mental damage to students caused by long-term and highly demanding schoolwork (Pines & Kafry, 1980; Meier & Schmeck, 1985).

In Western countries, therefore, scholars focus on the sequential influence of academic burden rather than the burden itself. In this paper, we consider both academic burden and its effects combined, in an attempt to present a comprehensive view of academic burden. The connotations of academic burden are examined from various angles, as described in the rest of this section, below.

### ***Physical and Mental Burden***

Academic burden can be divided into physical burden and mental burden. Physical burden refers to the consumption of physical energy; this is proportional to learning time and learning intensity and has cumulative effects. Mental burden refers to the consumption of mental energy. It is closely related to students' psychological burden of learning, their status and role among peers, and evaluation from others, especially educators (including the psychological burden caused by the expectations and requirements of parents and teachers). Physical and mental burden are positively correlated.

### ***Subject Curriculum and Activity Curriculum Burden***

In terms of content, academic burden encompasses a subject curriculum and an activity curriculum burden. The subject curriculum burden is the physical and mental effort made by learners to fulfil subject requirements, including requirements for schoolwork and extra-curriculum learning. The activity curriculum burden comes from the time and energy investment required to develop social skills and practical abilities through social practice, team activities and social activities.

### ***On-campus and Off-campus Academic Burden***

In terms of location, academic burden includes both on-campus and off-campus burdens. On-campus burden is directly related to school learning and is characterized by strong planning, low independence, and high intensity. Learning efficacy and intensity both effect on-campus burden. Off-campus burden comes from home learning and community learning; extra-curriculum tutoring, and training are its major sources.

## **Assessment Indexes of Student Academic Burden**

Scholars have not reached a consensus about survey and assessment indexes of academic burden. In Western countries, most studies are conducted using the 'education index system.' In Southeast Asian countries such as China, Singapore, Japan and Korea, scholars pay more attention to academic burden assessment indexes than their Western counterparts. Taking foreign national education index systems as references, this paper puts forward an academic burden assessment index framework that incorporates schoolwork, physiological and psychological burdens.

### ***Schoolwork Burden***

## Time Investment in Learning

Time investment in learning includes class time, homework time and extra tutoring time. Class time refers to the time that students spend on learning activities in the classroom every day (excluding self-study, after class activities and physical exercises). There are two kinds of homework time: time for homework assigned by schoolteachers and time for homework from outside the school, which might be homework assigned by parents or by tutorial agencies. Similarly, there are also two kinds of tutorial time: time for on-campus tutoring required by schools and time for home tutoring or tutoring provided by tutorial agencies.

## Difficulty of Learning Tasks

The key factor affecting the time investment required for learning is the difficulty of learning tasks, including the difficulty of subjects, homework and exams. Difficulty is determined by the specific requirements for each subject as determined by the quality standards formulated by each country, such as the education supervision and assessment index system in the UK (Abdgula, 2008), the guidelines for the assessment of compulsory education schools in Japan (Nakayasu, 2016) and the comprehensive assessment index framework for the quality of primary and secondary education issued by the Ministry of Education of China in 2013 (Wang, 2014). All put forward certain requirements that students must meet in learning tasks, such as subjects and homework.

## Schoolwork Quality

Schoolwork quality influences student learning efficacy, which further affects academic burden. Schoolwork quality includes the effectiveness of teaching, homework and examinations (tests). However, requirements for teaching effectiveness differ among different schools of education and standards for the effectiveness of teaching, homework and examinations vary. Therefore, evaluation on the effectiveness of teaching, homework and examinations are somewhat subjective.

## *Physiological Burden*

In index frameworks of academic quality surveys in various countries, physical health is considered an important index of sustainable study. Body mass index (BMI) and uncorrected visual acuity (UCVA) are regarded as comparatively objective metrics that can be applied to academic burden assessment. In addition, students' sleep time is affected by academic burden level. Thus, sleep time, BMI and UCVA are included in the survey index framework.

## Sleep Time

Student sleep time refers to the average total sleep time (including naps) of students every day during school sessions. An increase in student learning load leads to a reduction in student sleep time. It is one of the core indexes for students' physical burden assessment.

## Degree of Myopia

In the "International Myopia Institute (IMI) White Papers" published by the International Myopia Institute, myopia is a kind of ametropia, in which the light entering the eye parallel to the optical axis is focused in front of the retinal membrane when the eye adjustment is relaxed. This is typically due to the long anterior-posterior diameter of the eyeball or excessive corneal bending and/or increased lens power (Wolffsohn et al., 2019). Although student academic burden is not the only cause of myopia and other individual physiological causes exist, overall myopia rate of students and its change in a school can reflect academic burden to a certain extent, as students' main activity is learning.

## BMI

Body Mass Index, an indicator of total body fat, measures the degree to which an individual is overweight or obese and is commonly used as a standard for the level of healthiness throughout the world. In addition, the score calculated by BMI can provide information on the status of nutrition. Thus, BMI is adopted instead of the obesity index for assessments of academic burden because health level is not only negatively correlated with obesity but also with other factors such as malnutrition.

## *Psychological Burden*

Students' psychological burden comes mainly from a conflict between the requirements and expectations of families, schools and society of students' various roles, and the students' interest and ability in playing these roles. In Rong's (2017) study, learning pressure is measured as a spectrum from learning happiness to learning fatigue to learning anxiety to learning weariness. These four measures reflect changes in students' psychological pressure arising from academic burden. Among them, learning happiness refers to students that have a high satisfaction with their learning environment and academic performance. The transformation from learning fatigue to learning weariness reflects possible changes in a students' mood from depression to fear, then to boredom and indifference as learning pressure increases.

## **Factors Correlated with Students' Perception of Academic Burden**

### *Student Learning Efficacy*

Many researchers have proposed that academic burden is subjective to some extent and that it differs in its effect for different individuals. Ai (2015) suggested that, to achieve learning goals, learners will proactively make time and energy investment in study. The amount of investment is related not only to difficulty of the learning tasks but also to the students' learning willingness, learning ability and, especially, their learning methods. Likewise, Jin and Gao (2016) noted that learning efficacy, including students' self-efficacy and actual ability of learning, is a key factor affecting student academic burden. Individual differences in learning efficacy significantly affect the results of homework. Trautwein et al. (2006) found that the assumption that 'students assigned with heavy loads of high-quality homework will get better grades' is tenable only when emotional variables are incorporated into the analysis; it is true only for students that have few negative emotions when doing homework. This indicates that students' subjective feelings are also closely related to the acceptability of burden. Students with good learning methods and strong learning ability will complete learning tasks effectively and have a good emotional experience, which in turn motivates them to make further efforts.

## ***Teaching Efficacy***

There is a consensus in academia that improvement in teaching efficacy helps reduce student academic burden. Liu and Zhu's (2018) meta-analysis on the effect of teaching efficacy on academic burden indicates that teaching efficacy moderately reduces students' academic burden and that among all the elements of teaching efficacy, teaching environment (here mainly referring to interpersonal relationships at school) reduces students' learning pressure and homework time most significantly. Good teacher-student relationships and teachers' identity with the school are remarkable in their ability to alleviate student academic burden. Teachers' fair treatment of students, open attitudes towards students' opinions, encouragement of, and trust in, students and their belief that students' schooling is part of their overall development make students feel that learning is a happy and meaningful journey. Building a good teaching environment should thus be the top priority in enhancing teaching efficacy. Teaching efficacy primarily works on students' perception of academic burden and high teaching efficacy can reduce students' academic burden by alleviating learning stress and increasing learning interest.

## ***Parental Expectations***

Some scholars have suggested that the mechanism of parental expectations is similar to the Rosenthal effect, with parental expectation engendered according to the mechanism of "vision - expectation - action - reaction - acceptance - externalization" (Ren, 2004). Following this mechanism, parents generate expectations of their children's achievements (academic achievement, highest education, social achievement), moral character and interpersonal relationships.

Proper parental expectations can meet children's psychological needs for dependence, enable good psychological experiences, stimulate learning activities, and increase intellectual potential in their children. Parental expectations also contribute to a child's formation of self-expectation. However, excessive parental expectations tend to induce rebelliousness in children and thus affect their school behavior negatively.

According to sociology, parents tend to transfer the pressure and anxiety they feel in social comparisons of their children to other students, feeling obligated to discipline their children and urge their development (Garcia, Tor, & Schiff, 2013). When this comparative pressure exceeds the students' mental endurance, it leads to a psychological burden on the student.

## ***Social Demands for Educational Value***

Social expectations of education are that it meets the needs of social development, and that individual development is consistent with social development. From the perspective of economics, scholars such as Schultz (1961), Becker (1962) and Mincer (1958) argued that human capital, critical to economic development, could generally be obtained through education. The increase in a well-educated population implies a higher level of labor productivity and a greater ability to introduce advanced technology. As a result, students are not only affected by academic burden itself, but they also experience stress from social expectations of education. In the context of fierce competition for school progression and potential challenges to employment in future, students become the bearers of multiple burdens.

## **Rational Evaluation and Analysis on the Effects of Student Academic Burden**

### ***Reasonable Academic Burden***

For students, there are two categories of academic burden: reasonable burden and excessive burden. Reasonable academic burden is the necessary pressure associated with learning activities, the pressure that students must experience to forge their individuality and personality and learn the basic knowledge and skills necessary to meet the requirements of present-day society. Reasonable academic burden will stimulate a student's progress and promote a student's development.

### **Improving Student Character**

Reasonable burden and responsibility are not only necessary for student growth, but also an indispensable part of a student's social adaptation. Societal development requires that every generation must bear some pressure, suffering and burden during childhood. The complexity of modern society challenges people's stress tolerance. If students want to win in future competitions or cooperate successfully with others, they

must have a strong resistance to frustration as well as a strong personality and adaptability. Students' willingness to take on academic responsibilities and challenges undoubtedly plays a critical role in cultivating a student's resilient personality.

## **Beneficial to Student Mastery of Basic Learning Skills**

Learning is typically a tense and monotonous activity, demanding strong willpower, positive emotional elements, and cognitive abilities. At the stage of studying basic knowledge, when students are not ready to understand the significance and value of study, too much emphasis on learning interest and freedom is not conducive to students' mastery of basic knowledge and basic learning skills.

To lay a solid foundation for lifetime study, students must undergo certain basic knowledge collection and method training. A reasonable level of compulsory academic burden resulting from this process is not harmful to students' physical and mental health. Rather, it promotes students' comprehensive development (Qi & Sun, 2016).

## **Ameliorating Overall National Quality**

A history of world educational development indicates that academic burden affects improvement of the national basic education quality. The contemporary era has witnessed radical reforms in education. In drafting educational reform policies, whether to increase or reduce student academic burden is often a hotly debated topic in discussion.

Arguments on this topic originated in the USA. Under the influence of progressivism in education, the United States advocated "child centrism" in the early 20th century, emphasizing children's freedom, interests, and outdoor activities, and giving up training, burdensome studies and strict academic standards. In reducing student academic burden, the country experienced a decline in student academic and moral levels, and a rise in crime rate (Beck, 1942). The successful launch of the Soviet Union's first man-made satellite in 1957 awakened American society to the importance of basic education. As essentialism began to prevail, importance was again attached to the idea of strengthening basic education and cognitive training. In 1983, under the policy of "providing leadership, constructive criticism and effective help to primary and secondary schools," the National Education Commission led by Bell submitted to the U.S. Secretary of Education at the time the report, "A Nation at Risk: The Imperative for Educational Reform," which exposed various flaws in American education, the sequential crises faced by the system and then put forward suggestions on teaching content, standards, leadership and funding (Gardner, 1983).

The former Soviet Union and Japan underwent similar educational reforms. To improve student mastery of knowledge in compulsory subjects, the former Soviet Union has implemented a series of educational reforms since the 1930s, such as reinstating traditional subject-based teaching, conducting class teaching, adopting uniform textbooks for long-term use, and reducing teaching time in non-compulsory subjects. This reform resulted not only in increases in student academic burden, but also in advances

in educational quality, laying a solid foundation for the Soviet Union's rapid growth in science and technology. Subsequently, numerous reform policies have been issued for the purpose of producing higher-quality labor. In the 1980s, after entering a new phase of educational reform, the former Soviet Union started discussions on academic burden from the perspective of student comprehensive development and improvement in psychological health. In view of the new requirements for talent in modern society, students' sense of responsibility and obligation in learning was emphasized and the importance of academic burden highlighted.

Corresponding to Japan's "Third Voyage" plan in the early 1980s (an attempt to transform Japan from an economic power to a political power), the country began its third educational reform. Although changes have been made to the so-called "hell-like" and "highly uniform" education system, with efforts made to incorporate "relaxation," "happiness" and "personality development," student academic burden has not lightened significantly. In Japan, academic pressure has become essential to cultivating students' sense of responsibility and setback-resistance. In addition, adequate basic knowledge collection and relevant learning skills training are emphasized as fundamental for obtaining higher levels of knowledge and skills.

The evolution of educational policies in the United States, the Soviet Union and Japan indicates that an appropriate student academic burden plays an important role in the development of a country and its education. The improvement of a nation's basic quality of education is often based on maintaining appropriate levels of academic burden.

## ***Excessive Academic Burden***

Excessive academic burden, in contrast, can lead to negative feelings such as tension, anxiety, aversion, fear, etc. The consequences of these feelings are counter to students' healthy growth, as expounded on below.

## **Inducing Physical Unfitness and Illnesses**

Inappropriate levels of academic burden can cause a variety of illnesses. Honkonen et al. (2006) in their study of job burnout, noted that job stress erodes human health over time, leading to skeletal muscle diseases, cardiovascular diseases, and some allergic reactions. Many scholars refer to this conclusion in their study of academic burden. Nevertheless, Kahill (1988) asserts that there is insufficient evidence to attribute systemic diseases to academic burden and that only physical conditions such as insomnia, nightmares, headache, stomach pain, intestinal flora imbalance and fatigue are likely to be significantly and positively correlated with academic burden.

In addition, an unduly heavy academic burden deprives students of sufficient time for rest and physical exercise. The "2020 Blue Paper: Report on China National Mental Health Development (2019-2020)" released by the Institute of Psychology of the China Academy of Sciences in 2021 shows that standards for sleep time are not met

by 95.5% of primary school students, 90.8% of junior middle school students and 84.1% of senior middle school students in China (Fu, Zhang, & Chen, 2021).

Insufficient rest and exercise time can lead to poor physical function, rapid decline in visual acuity and rapid changes in body mass. Zhu et al. (2017, December 24) associated academic burden with grade level prevalence of students' physical activity and sedentary behaviors, analyzing the data of 48118 children in Shanghai in the 2014 survey of Physical Fitness and Health Index of Children and Adolescents (PFHICA). Children in transition grades 6 and 9 (when they face entrance exams) and throughout all high school years were less physically active than other grades. This occurs despite these children giving up most of their screen viewing time (on mobile phones, for example). Therefore, academic burden appears to be the main reason for lack of adequate physical activity. Morgan et al. (2012) emphasized in his study that myopia has become a major problem facing students in Southeast Asian countries and that the high rates of myopia are related to the increase in academic pressure and change in lifestyle, as both reduce children's time spent on outside activities.

## Causing Psychological Burden and Harm

Existing research indicates that long-term excessive academic burden has a direct negative impact on student emotions and psychology, manifested as increased depression levels. Depression is a state of mind that presents as gloominess, low spirits and negative attitudes towards everything. To students, unfavorable factors such as dramatic change in the environment and increased academic burden often provoke prolonged and drastic psychological reactions that can lead to depression (Mei et al., 2021).

Bossy (2000) investigated the stress faced by Japanese students, especially high school students and found that the stress experienced by Japanese students while in pursuit of academic achievements, especially when preparing for college entrance examinations, is harmful to their mental and physical health. Extreme cases like bullying and school-related suicide may occur.

A cross-sectional study conducted by Zhu et al. (2021) found similar results. In a sample of 1,533 adolescents in Eastern China that examined the effect of academic burden on physical activity and sleep time, and its correlation with anxiety and depression. The study results confirmed that academic burden is negatively correlated with physical activity and sleep time and positively correlated with levels of anxiety and depression.

## Lowering Student Learning Effectiveness

Deb, Strodl, & Sun (2015) conducted a survey by questionnaire of the correlation between academic burden and student mental health. One hundred and ninety senior middle school students in grades 11 and 12 (average age = 16.72 years) from three government-funded schools and three private schools in Calcutta, India, participated. Nearly two-thirds (63.5%) of students reported feeling stressed due to academic pressure. Fur-

ther, academic burnout was positively correlated to academic pressure and a student's reaction to pressure. Prolonged academic burnout significantly compromised learning outcomes.

## **Hindering Individual Overall Development**

An individual's comprehensive development refers to their lifelong development in physical, cognitive, social, and emotional dimensions. Some scholars define inappropriate academic burden as any that leads to students experiencing negative feelings during learning tasks and while working in the study environment. It is difficult to cultivate students' interests and self-motivation in learning when they have strong feelings of being compelled to study. Forced study damages self-reliance and self-confidence in learning and substitutes simplified training for reflection on learning methods. As a result, learning becomes a process of monotonous memorization while neglecting higher order thinking abilities such as imagination, logic, and creativity (Zhang, 2020). Moreover, the heavy schoolwork loads and long learning hours typical of excessive academic burden reduce individuals' sport and social time, leading to deficiencies in social skills. Thus, an academic burden hinders the all-round development of individuals.

## **Suggestions Based on Humanistic Thought**

The goal of current research on academic burden is scientifically judge what levels of burden can best promote student growth, in which the value of students as human beings is emphasized. Examination on academic burden is not meant to simply reduce student learning loads, or to justify pushing students forward with heavy workload, but rather to determine what levels of burden is beneficial to their healthy growth and long-term development.

### ***A Rational Outlook on Education should be Adopted to Avoid Either Exaggerating or Ignoring the Impact of Academic Burden.***

The essential goal of education is to cultivate individuals with integrity, that is, "whole" human beings. Education is responsible not only for imparting knowledge and culture, but also for the construction of a student's spiritual world, including a reasonable outlook on life and good values. However, the prevalent concepts of "omnipotent education" and "useless education" are both biased against this educational essence. At one extreme, exaggeration of the role of learning loads can leave students overwhelmed by meaningless and repetitive exercises and training. At the other extreme, ignoring the value of a proper school workload and delivering prejudiced judgements on education to the public can also mislead students, impeding their ability to acquire initiative and a proactive approach to study and life. It is thus key to bear in mind that in education the student is an end rather than a means. To meet social requirements for education in so-

cietal development, more emphasis should be placed on a student's all-round growth (Meng, 2017). In view of this, academic burden should be re-examined. Any discussion on appropriate levels of academic burden must be centered on the healthy development of individuals.

### ***Learning and Teaching Methods should be Improved to Enhance Study Efficiency and Effectiveness.***

Attention needs be paid to the actual status of each student's learning, including their feelings and experiences of learning, cognitive abilities, emotions regarding school, and behavioral disposition. Considerations of individual perceptions of academic burden can help improve each student's learning efficiency, raise the student's quality of life, and reduce students' physical and mental burden (Ai & Wang, 2016). In addition, teachers should increase their awareness of the advantages and disadvantages of academic burden and be committed to improving teaching methods to better regulate students' academic burden (Li & Luo, 2014).

### ***The Quality of Student Assignments should be Raised, and the Effect of Marginal Utility Avoided.***

In December 2012, the Organization for Economic Cooperation and Development (OECD, 2012, December 3) released the "Program for International Student Assessment (PISA) 2021 Results." Among the students participating in the survey, the average homework time of students in Shanghai, China, was 13.8 hours a week, or less than 2 hours a day, which, while hardly a heavy academic burden, was far from being efficient. In contrast, Korean students spent an average of three hours a week on homework, but their scores were only 45 points lower than those of Shanghai students. Although a large quantity of exercise is helpful to students' memorization and mastery of knowledge, the rule of diminishing marginal utility is also applicable to homogeneous exercises; that is, with an increase in the quantity of similar exercises, the benefits from increased exercises will diminish. This phenomenon frequently occurs in Southeast Asian countries, where, affected by the entrance examination systems, students tend to practice repetitive exercises to cope with the entrance examinations. A reduction in academic burden does not simply mean lessening the quantity of homework and tests. Rather, it is about optimizing assignment quality. To do so, we should try to remove the monotonous, repetitive, and imitative teaching contents and exercises, and make on-campus and off-campus assignments more effective and inspiring. Moreover, the difficulty of homework should vary among students according to their abilities. Information technology can be employed to personalize assignments to the specific academic levels of individuals and to innovate new forms and content of homework.

Education is an essential component of human socialization. While education exists, academic burden will be present. The necessity and validity of an appropriate

academic burden have been fully discussed and factors influencing students' perceptions of it are examined in this paper. Further research should focus on methods to make academic burdens more friendly and humanistic to students and on how to optimize educational methodology. Social development and the concomitant advances in technology have dramatically changed the way people work and live. Surely, these advances will make significant differences to students' learning styles in the future.

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# The Development of Home-School Partnership Courses: A Practice Based on Xingzhi Tao's Life Education Theory

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**Abstract:** Home-school partnership plays a critical role in student growth and the home-school partnership courses provide important paths to achieving ideal results of the partnership. Under the guidance of the three principles of “life is education”, “society is school” and “integrating teaching, learning and practice” in Xingzhi Tao’s life education theory, Shandong 271 Education Group developed the parent school course and the family civilization course, which turn out to be a systematic support for the home-school partnership program. This paper analyses the status quo of home-school cooperation in China and focuses elaborations on the components and practice of the two courses in Shandong 271 Education Group.

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**H**OME-SCHOOL partnership in this paper refers to the cooperation between families and schools in student education with the goal of promoting student healthy and comprehensive development. This concept originated in the USA, also expressed as “parental involvement” and “school, family, and community partnerships.” There has been a consensus among scholars that families and schools should give full play to their respective advantages and make joint efforts in children’s development through effective programs (Epstein, 2001). Since 1950s, home-school partnership has been drawing increasing attention from researchers, and gradually become an important trend in global educational development. Home-school educational cooperation in China was brought back to the right track in the 1980s and has been attached importance ever since. The life education theory of Xingzhi Tao (one of the most influential educators in the 20th century in China) provides an important theoretical support for current practice of home-school partnership in China. In particular, the three principles of “life is education”, “society is school” and “integrating teaching, learning and practice” from Tao’s theory are of great significance in guiding home-school partnership.

Currently, problems exist in home-school educational partnership, including disagreement over educational goals, lack of diverse partnering vehicles and ambiguity of family-school responsibility division, which might compromise the effectiveness of partnership or even lead to conflicts between parents and schools. Schools, as the dominant factor in home-school partnership, should take on the responsibility to explore new paths of home-school cooperation and build appropriate patterns for the partnership. Shandong 271 Education Group, a private 12-year boarding school conglomerate with more than 80000 students, has conducted fruitful exploration in creating home-school partnership program. This paper tries to discuss how to apply Xingzhi Tao’s life education theory to the design of home-school partnership courses and explain the effectiveness of the courses in in-depth cooperation between families and schools.

## **The Evolution of Study on Home-School Partnership and its *Status Quo* in China**

### ***The Evolution of Research on Home-School Partnership***

Home-school partnership originated among the 18th century immigrants in the United States. In the 1950s and 1960s, the issue of home school cooperation attracted considerable attention in countries with highly developed education such as European countries, the United States, South Korea, and Japan, where parents’ right to participate in school education is guaranteed through legislation. With deepened research, scholars found that apart from schools, families and communities had impacts on adolescents’ study as well (Hobbs, 1978). Bronfenbrenner (1994) further divided the external environment

affecting teenagers' development into four systems: micro, medium, foreign, and macro. Coleman (1997) introduced the social capital theory into education. He summarized parental attention to children, family educational investment, parental educational expectation, parent-child interaction, and parents' social network as family social capital. Through a survey, he found that students from families with relatively more social capital had lower dropout rate and better academic performance. This conclusion was supported by the Coleman Study (Coleman, 1966), which indicated that family variables explained about half to two-thirds of the differences in students' academic performance. Epstein (2001) consolidated families, schools, and other social institutions in examining their roles in educational partnership and believed that the influence of school, family and community on children's education was not generated separately, but rather simultaneously and continuously. Given the above studies, a relatively complete theoretical foundation has been established for the research of home-school partnership.

## ***The Status Quo of Home-School Partnership in China***

The first study on home-school partnership in China was published in the column of "family and school child education" in *People's Education* in 1950. For more than 70 years since then, the issue of home school partnership has been studied by scholars from different fields to promote family and school cooperation in education. The Ninth Five Year Plan for Family Education jointly promulgated by All-China Women's Federation and the State Education Commission in 1996 represented China's first attempt in legislating family education. By the time of publication of the Family Education Promotion Law of the People's Republic of China on October 23, 2021, the contents and methods of family education had been continuously enriched and improved.

However, home-school partnership in China still face difficulties, mainly reflected in the incongruent home-school education goals, limited partnering vehicles and ambiguous division of family-school responsibility.

## **Lack of Identity in Student Education Goals**

Due to insufficient exchange between parents and schools, the consensus on child education goals has not been reached. Understandings of the essence of education differ among families and schools. Particularly, traditional authoritative family education ideas still prevail, in which students can merely act as passive recipients of knowledge; Excessive emphasis on test scores is accepted consciously or unconsciously. In our current educational culture, neither is students' identity as "pro-active learners" and "self-educators" well recognized, nor is students' spiritual growth fully respected (Gao, 2019).

## **Limited Partnering Avenues**

Home-school partnership consists of interactive activities, which require mutual understanding and coordination between families and schools. Nevertheless, in current home-school interactions, teachers typically have difficulty in obtaining parents' support due

to limited opportunities of communication with parents. Parent meetings and home visits are almost the only avenues for home-school interactions.

## **Ambiguous Home-School Responsibility Division**

From the perspective of social interdependence theory, some scholars define home-school partnership as a process in which families and schools gradually form a positive interdependent mechanism through continuous interactions and discussions, and propose three cooperation patterns, namely “home-based cooperation”, “school-based cooperation” and “home-school mutual assistance” (Li & Yue, 2018). However, in practice, it is difficult to determine the respective responsibilities of parents and schools. At one extreme, in present school-dominated partnership, schools tend to take on all the educational responsibilities while parents seldom participate in school activities. At the other extreme, some teachers might transfer part of their professional obligations to families, requiring parents to tutor children in schoolwork. In addition, some parents are reckless enough to try to interfere in school operation, causing trouble to normal teaching order. Thereby, the obscured responsibility division and the sequential conflicts become predicaments in home-school partnership in China.

## **Home-School Partnership Components in Xingzhi Tao's Educational Theories**

Xingzhi Tao was a great educator in China, devoting all his life to the cause of education and making pioneering contributions to the modernization of Chinese education. He not only established his own educational thought, but also conducted much educational practice. The life education theory is the cornerstone of Tao's educational thought, emphasizing education for life, education with life, and education for progressive needs in life. It is a multi-level, continuously developing and systematic educational theory (Zhang, 2017).

The three well-known principles of the life education theory are “life is education”, “society is school” and “integrating teaching, learning and practice.” Among them, “life is education” is the soul of the theory, meaning education is a lifelong co-existence with human life. “Society is school” emphasizes the need to establish an ideal learning-oriented society and to turn the whole society into a big school. “Integrating teaching, learning, and practice” is put forward as a methodology of the theory, highlighting the leading role of practice in the three principles and the necessity of acquiring knowledge from practice (Hu, 2007).

Tao's life education theory is about education on life and more importantly, about education of outlook on life. Education is not only derived from and for life, but also has the great mission of transforming the world. Tao proposed that life education should cultivate living capability and creativity and foster the consciousness of making a difference to the society. For students, participation in social life is mainly realized

through school life and family life. Therefore, home-school partnership is a powerful means to achieve the goal of life education.

Based on the life education theory, 271 Education Group succeeds in developing the parent school course and the family civilization course after 13 years of exploration. “Life is education” ascertains the value of the two courses, “society is school” determines the components of the courses, and “integrating teaching, learning and practice” provides measures of implementation. The two home-school partnership courses provide paths to the success of students’ life education.

## **The Design of Home-School Partnership Courses Based on Tao’s Life Education Theory**

### ***The Value and Goal of Home-School Partnership Courses Oriented by the Principle of “Life is Education”***

According to the principle of “life is education”, the relationship between life and education is that life determines education and education in turn transforms life. The home-school partnership program centers itself on life, including students’ school life and family life, to trigger parents’ interest of participation. Students perceive life, wisdom, and truth in their growth first through their physical senses. Practical activities in life are the most important means for students to perceive the world and realize healthy growth. We set student lifelong development as the goal of our program to guide parents, teachers, and students to give up utilitarian and biased educational ideas.

From the perspective of student development, we pursue student physical well-being, academic success, passion for life, strong thinking and learning ability, good self-management skills and leadership ability. In addition, in life education, students learn to take responsibility, responsibility for life, for family, and for society. Only by experiencing responsibility assumption can students acquire the ability to take responsibility.

Moreover, home-school partnership program is also aimed at promoting parent and school development. Teachers learn about students’ study and life at home through home-school interactions, which help design personalized teaching to individual needs; Schools can take constructive suggestions from parents to improve educational quality. When it comes to parents, the program guides them to reflect on what “true education” is and warns them of the prevalent utilitarian pursuit in education; It reminds parents to make the best of family education and housework to cultivate children’s practical skills; It advises parents on how to build a democratic family relationship with mutual respect and support; It encourages parents to learn, to read, and to think so that they can be role models and lifelong mentors for their children.

## ***Components of Home-School Partnership Courses Based on the Principle of “Society is School”***

“Society is school” advocates connection between society and education, and utilization of all social components as educational resources. In the process of student growth, parents are the best educational resources, families are the best learning locations, and home-school partnership is the best social resources. Based on the needs of life and the goal of students’ life education, 271 Education Group designed the contents of home-school partnership courses.

### **The Parent School Course**

As social beings, students are directly affected by parents’ values, ways of thinking, behavior patterns and lifestyle. Therefore, the core objective of the parent school course is to educate parents to understand the value and significance of education, and to give up irrational pursuit of test scores. After a series of training and participation, parents can accept correct educational ideas, and a bridge will be built between school and family education. The parent school course consists of four modules, namely educational value module, positive acceptance module, teaching management experience module and parent-child mutual appreciation module.

#### ***Educational Value Module***

Educational value module is composed of topic-based lectures and training with focus on educational basics, child overall growth, parent-child communication. Experts and headmasters are invited to give lectures to parents of all students in the school and training is provided by each grade on topics such as how to face angry children, what else to be done in family education, to be smart parents, love education, how to be good listeners, appreciation education. Training on different topics is provided to divided groups of parents, during which professional family education tutors and teachers will guide parents on how to deal with parent-child relations. Therefore, this module helps parents and teachers reach agreement in their understanding of educational value and goals. The results of the parent school course are assessed each semester at grade level to incorporate parental education into the class and grade teaching management systems.

#### ***Positive Acceptance Module***

This module is intended to increase parents’ awareness that all children have their own characteristics and that they should be accepted as unique individuals. The module includes two parts: i) special training on how to accept children positively, in the form of weekly lecture (online or offline) named Parent Lecture Room. It mainly dwells on two topics: “Every child has unique talent” and “every child is different;” ii) parent club activities, through which parents exchange ideas and skills in interaction with children.

### *Teaching Management Experience Module*

Parents are invited regularly to participate in classroom activities. It provides parents the opportunity to witness the school teaching models, observe children's performance in class and evaluate teachers' classroom practice; Meantime, parents have the chance to recall their role as students by experiencing classroom learning and classroom atmosphere. Moreover, parents with professional expertise are invited to give lectures to children to experience the role of teacher. Through this module, parents become better learners and educators, and can create a better environment for their children's growth at home.

In addition, parents are also invited to participate in students' extracurricular activities, such as watermelon grafting, Mount Tai root tracing tour in Qufu, Yangjiabu wood engraving picture appreciation tour, 65-kilometer hiking, as well as community service and voluntary activities in winter and summer vacations. Schools organize various festivals regularly including food festival, science and technology festival, reading festival, art festival and New Year party. Parents are involved in the organization of these events in different ways; Some even contribute their social resources to the festivals. Participation in extracurricular activities enables parents a comprehensive knowledge of children's study and life in school and helps build a close and harmonious parent-child relationship.

### *Parent-Child Mutual Appreciation Module*

The school regularly organizes activities like Appreciation Week to make students aware of parents' love for them and their commitment to family and work, to stimulate children's gratitude for parents' devotion. In the school where all kinds of children live and study together, parents witness the differences among children and find their own children's unique personalities and strengths. They will realize that education progress slowly, and it demands patience to wait for children's talent to be released. A holiday activity called Family Appreciation Week is designed for children and parents to spot each other's strengths, to appreciate each other, and to enhance children's self-confidence and harmonious parent-child relationship.

## **Family Civilization Course**

Life education at home in terms of family virtues, wisdom enlightenment, healthy lifestyle, art and aesthetics, housework training, interpersonal relationship and responsibility assumption is imposed on children by parents in spontaneous or conscious ways. It is greatly influenced by social customs and family cultural traditions and typically exhibited in the forms of family rules and styles. Given this, the Group designed the family civilization course with four modules covering reading, home democracy, housework, and social life.

### *Reading Module*

The reading module is targeted at creating an educationally oriented family atmosphere. According to the book list recommended by the school, parents and children make respective reading plans with detailed requirements such as reading list and reading time. Parents are asked to spend no less than two hours a week in reading and sharing their reading insights with their children; They are also asked to upload reading-related photos and insights onto online reading group to be assessed if they have reached the parent-child reading standards. This reading plan triggers parents' and children's strong interest in reading, which certainly helps improve their competence.

### *Home Democracy Module*

Family civilization is a matter not only for parents, but also for children. Only when parents and children interact effectively can family civilization progress become possible. Home democracy module advocates that all family members have an equal right to be involved in running the family. Parents and children take turns to act as family CEO so that children can participate equally in the decision-making of all family affairs, ranging from family financial plan and family tour plan to daily three meals. Such practice helps develop children's awareness of democracy and decision-making ability and build a harmonious family relationship of equality and mutual assistance among family members.

### *Housework Treatment Module*

This module covers mainly housework such as washing dishes, mopping the floor and personal sanitation tasks as well as food preparation. In doing housekeeping, children not only learn housework skills and enjoy work results, but also experience the heavy loads and triviality of housework, which can educate them to develop good habits. In turn, children's behavior can drive parents to do better in sanitary maintenance, sundries storage and even public welfare behavior such as garbage sorting and old clothes donation.

In food preparation, by purchasing ingredients, cooking delicious food together with parents and cleaning up after dinner, children learn essential life skills and develop structured thinking ability. Cooking itself is a good way to make children deft, to develop intelligence and grow wisdom. Moreover, through meal preparation, children can fully perceive the life burden of their parents and the tacit understanding between parents and children is enhanced.

Life education is a generative process. With the experiential learning in doing housework, students not only acquire life skills, but also build up faith and courage to create the future.

### *Social life Module*

This module includes three parts, that is, social life etiquette, social life experience and social life summary. First, parents are required to impart social life etiquette to their children, and children can also collect and learn the rules through the Internet. Then

parents take children to experience social life to further internalize the previously informed rules and manners. Finally, the process of social life is reviewed, and the lessons summarized. Through social life, parents can guide children to integrate themselves into society and children can perceive what is meant by the idea “society is school, society is life, and life is education.”

## Practical Application of the Home-School Partnership Courses Based on the Principle of “Integrating Teaching, Learning and Practice”

### *Guiding Roles of Home-School Partnership Courses in Student, Teacher, and Parent Development.*

The home-school partnership program has a significant positive effect on student comprehensive development. Through special training, children understand the objectives, contents, implementation measures and assessment methods of the family civilization course. In activities designed for the courses, children and parents make decisions on family affairs, read, exercise, and do housework together.

Furthermore, the program has become a powerful motivator in teachers’ professional development. To communicate effectively with parents, teachers must improve their academic competence. Teachers with 271 education group are conscientiously studying the history of their respective disciplines and devoting their time and energy to the study on twelve-year curriculum integration; Their teaching level is continuously improved by the selection of excellent teaching models and a wide range of exchanges with other academic institutions; Through special training centered on family education, teachers are better informed of family education skills and create smooth home-school communication channels; Finally, training in curriculum integration, classroom teaching and family education enhances teachers’ overall educational competence and can generate more productive home-school cooperation.

The parent school course effectively promotes parental involvement in child education. Parents obtain full understanding of school curriculum and management in an all-round way by supervising curriculum implementation, participating in classroom activities, and taking part in various extra curriculum activities; Parental study group, writing group and reading club are set up to integrate parents into the school-family community. In the process of participation, parents deepen their understanding of the value of education and acquire the opportunity to know their children better. In addition, the program also helps parents form habits of reading, writing and reflection, and become real learners, researchers, and educators.

### *Operating Mechanisms for Home-School Partnership Program*

The operating mechanism of family committee ensures the successful implementation of home-school partnership program. The three-level parent committee (school, grade,

and class) with a separate office on the campus have established rules and regulations for parental participation in child education. The parent committee take part in formulating schoolwork plan at the beginning of the semester and summary report at the end of the semester and participates in major school events. Other parents (three to five persons per day from each class) take turns to be present on campus to watch the classroom activities, participate in school research and interview teachers and students so that they can be involved in various school affairs in an organized and regular manner. Meantime, they can experience children's daily study and life including three meals and sleep; The time they spend with teachers and children on campus make their relationships closer.

The parent school course and the family civilization course are routinized and institutionalized. They are organized with implementation plans, timetabled sessions, and feasible approaches. The courses are welcomed by students and well recognized by parents due to the clear objectives, concrete contents, and ever improving assessment methods.

To give full play to the role of model parents, the school empowers the family committee to select excellent parents and commend them regularly so that their practice and experience can be shared with other parents. In mid-term and terminal assessments, the school selects the excellent individuals and teams in the implementation of the two courses and use models' stories to motivate all parents to be fully involved in the home-school partnership program.

## **Conclusion**

Homes and schools are the most important factors influencing students' life and growth. Based on the three principles of "life is education", "society is school" and "integrating teaching, learning and practice" in Tao's life education theory, the parent school course and the family civilization course developed by Shandong 271 Education Group have been playing significant roles in home-school partnership. Both parents and schools have made the best of their respective advantages to complement each other in child education. In the 13-year practice, the objectives, contents, implementation measures of the courses have gradually improved. They become effective platforms for in-depth cooperation between families and schools, through which the efforts of students, parents and teachers are integrated to promote students' comprehensive growth.

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# The Construction of Educational Community based on the Technology of Internet plus Satellite Live Broadcasting

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**Abstract:** *In the current climate of pursuing educational equity, the construction of educational community is a worthwhile experiment in achieving equitable development of urban and rural education. Establishing a multi-channel cooperation mechanism between urban and rural schools and giving full play to the existing high-quality educational resources are feasible and efficient ways to reach quality and equity education. Based on the technology of Internet plus satellite live broadcasting and its own resource advantages, No.1 Middle School of Zhengzhou constructed an educational community across time and space, which effectively promotes balanced development of education in the region and has enhanced the overall educational level there.*

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## **Introduction**

**Q**UALITY and equity education has become an important issue in the global educational development. Emphasis on equality of opportunity is shifted onto equality of results and the quality of equity education is highlighted. To pursue results-oriented educational equity, Britain has conducted relevant educational reforms since 1997 and issued a series of texts of educational policies: *Schools for Excellence* (1997), *The success in Learning* (1999), *Schools: Achieving Success* (2001), *Every Child is Important: for Children's Change*, *Higher Standards and Better Schools for All students: More Choices for Parents and Students* (2005). Publication of these texts and implementation of the reform policies were aimed at reducing the impact of family background on education equity, alleviating unfairness and imbalances in education, and achieving results-oriented educational equity (Sahlberg, 2016).

To promote equality and high standard in education, Australia carried out a comprehensive reform of primary and secondary education with emphasis on both quality and equity early this century. Schools paid more attention to building up students' international competitiveness to meet social demands; Meantime, educational equity was linked with educational quality by strengthening the construction of educational infrastructure, prescribing a national uniform curriculum, and building a national intelligent school partnership to accelerate the advances of information technology in education (McGaw, 2006).

China has also been committed to the achievement of educational equity since the founding of the People's Republic of China. In 1949, China established an educational system for the people to promote universal education. Since the reform and opening up, continuous efforts have been made to upgrade educational equity from opportunity fairness to equality in results. The state promulgated the *Guiding Opinions on Accelerating the Development of Education in the Central and Western Regions*, the *Notice of the Ministry of Education on Several Issues on Strengthening the Management of Basic Education*, the *Three-Year Action Plan for Preschool Education*, the *Rural Teachers Support Plan 2015-2020*, the *Nutrition Improvement Plan for Rural Students in Compulsory Education*, the *National Development Plan for Children in Poor Areas 2014-2020* and other policies (Yuan, 2019).

However, the long-standing urban-rural dual structure and the inter-regional imbalance of economic and cultural development in China impose profound impacts on the distribution of educational resources among regions, resulting in disparities between urban and rural schools in terms of educational investment, human resources, facilities, and teaching quality (Ma, 2008). To make the issue of quality and equity education more pressing, people's demand for high quality education is ever increasing, especially when the level of socio-economic development and people's awareness of the importance of education raised.

In the context of existing differences in educational levels, the construction of educational community is a critical path to the achievement of high-quality and balanced development of education (Chen, 2016). The integration of urban and rural edu-

education is not only the goal of balanced development of education, but also the solution to the inequality in education. Educational communities led by key schools with high-quality educational resources in the region are applicable ways to implement the integrated development of urban and rural education. In this article, educational resources refer to the means which can be used to reach educational objectives, including school management mechanism, teachers' professional competence, curriculum design and teaching models.

As a key link in the global educational modernization, the application of information technology in education has become the orientation of educational development in various countries in building information ecology. The rapid development of satellite live broadcasting in China and the popularization of large-scale, high-quality, and low-cost live broadcasting technology as well as the robust advance of Internet technology make the spread of high-quality educational resources possible (MA, 2021). Educational communities aided by the technology of Internet plus satellite live broadcasting can break through traditional time and space restrictions and connects teachers from different schools and areas to carry out educational activities. This can not only promote the transmission and sharing of high-quality educational resources, but also brings new opportunities of development to those advantaged schools.

As one of the key schools in Henan Province, Zhengzhou No. 1 High School abounds in educational resources. To contribute to equal development of education in the region, No.1 Middle School of Zhengzhou started in 2006 to construct an educational community across time and space based on the technology of Internet plus satellite live broadcasting. This community involves 82 schools in 70 counties and cities in Henan Province, and a cumulative total of 1835 online classes, 119275 students and 11010 teachers since 2006. This paper first applies the resource dependence theory in the conceptual analysis of educational community and then present the practice of the educational community built by No.1 Middle School of Zhengzhou and its effectiveness in promoting regional educational equity based on the information technology.

## **Resource Dependence Theory and the Regional Educational Community**

Resource dependence theory was first put forward by Pfeffer and Salancik (2003) in *The External Control of Organizations: A Resource Dependence Perspective* and often employed in management and economics. It raised four important hypotheses: All organizations are dependent on the environment for their survival; The environment, to a considerable extent, contains other organizations; The resources one organization needs are thus often in the hands of other organizations; Legally independent organizations are therefore dependent on each other. Referring to this theory, we regard the regional educational community as a collective of educational units in cooperation based on resource dependence and set the goal of the community as integrating the educational resources in the region to promote the improvement of educational quality of all units in the region.

The basic idea of regional educational community across time and space is to establish an operational system to enable the sharing of high-quality educational resources through the technology of Internet plus satellite live broadcasting so that the high-quality educational resources in developed areas can be extended to less developed areas, breaking through the boundaries of time and space, and prompting the balance of high-quality education among urban and rural schools. The value of such an educational community lies mainly in three aspects: The coverage of educational resources is no longer limited by teaching locations in traditional education and a new educational system and educational ecology can emerge; The reorganized educational resources can help promote the growth of both teachers and students. Third, disadvantaged schools can achieve significant development by employing the shared resources and disparities in educational levels among schools in the community can be alleviated.

## **Research and Practice of the Construction of Educational Community for Balanced Educational Development Based on Information Technology**

### ***Establishing an Educational Resource Sharing Platform Supported by Internet plus Satellite Live Broadcasting***

“Internet plus education” is an important component of China’s “Internet plus” strategy and a powerful driving force in promoting the modernization of education. Satellite live broadcasting is a satellite transmission mode in which geostationary orbit satellites are used to transmit radio, television and multimedia data directly to small-scale organizations and families. Compared with traditional broadcasting and TV transmission mode, satellite live broadcasting has the characteristics of wide coverage, strong two-way data transmission, high-quality restoration of images and sound, simple reception, low cost, and user friendliness. The combination of Internet and satellite live broadcasting technology provides an excellent platform for multi-level and multi-directional transmission of educational resources, a successful example of integration of traditional educational resources and modern information technology.

In contrast, traditional educational resource platforms tend to be simple collectors of information and can only serve a school or a small group of schools, lacking in an effective sharing mechanism and the capacity of transmission region wide. In terms of contents, traditional platforms provide mainly texts, but few videos; The sources are typically limited to the self-supply of information from a small group of schools, not enough to form a complete teaching system; The resources are not students oriented. Thus, they cannot meet the demand for a wide range of knowledge. In terms of the technical capacity, traditional platforms have difficulty in meeting the requirement for

data concurrency, information access and information storage in a large area, and lack long-term plans and sound foundation of infrastructure (Wu, 2017).

Based on extensive research, careful planning, and small-scale experiments, in August 2006, Zhengzhou No. 1 High School established the first distance education school specializing in sharing high-quality teaching resources in senior secondary education through live broadcasting, named Zhengzhou No. 1 High School Distance Education Campus. The distance education campus aims at resource sharing and common development, overcomes shortcomings of traditional modes, and presents a cutting-edge interactive teaching model supported by Internet plus satellite live broadcasting technology. With the aid of the network, the knowledge transmission and acquisition are no longer limited by time, place, and teaching environment. Teachers in the community can obtain high-quality educational resources through the platform at any time, which supplies opportunities to promote the balanced development of education in the region.

## ***Building an Educational Community Across Time and Space***

At present, the disparities between urban and rural areas in China's compulsory education are no longer caused by the gap in facilities, but rather by the differences in educational resources such as school management mechanism, teachers' professional competence, curriculum design, teaching models (An, 2019). Therefore, building an educational community across time and space to share excellent educational resources with schools weak in educational resources is an effective technological solution to the problem of educational inequity.

Zhengzhou No. 1 High School uses normal teaching classes as the live broadcasting classes. According to the school curriculum plan, each live broadcasting class is allocated an outstanding teacher of the subject. The chosen classes are broadcast live and received by the remote terminal classes in the community through the live broadcasting system. Each terminal class is staffed by teachers of various subjects as usual. Thus, this teaching model combines teaching of online outstanding teachers with meticulous offline tutoring. Meanwhile, all remote schools can also transmit their respective quality resources to the satellite live broadcasting system for open sharing. To ensure smooth development of the educational community, three priorities are highlighted as follows.

### **Common Development of Teachers in the Community**

Teacher professionalism is a key determinant of teaching quality. To improve professional competence of all teachers in the community, live broadcasting class teachers and remote terminal school tutors conduct online teaching research and lesson preparation at scheduled time every week. Zhengzhou No. 1 High School regularly hosts seminars, academic exchanges, and high-level competence training. Other schools in the community also hold activities such as mutual visits of teachers, presentation of model lessons

by outstanding teachers, and off-campus teaching research, to enable teachers to fully exchange teaching research results and make progress together.

## Integration of Online and Offline Teaching

The prevalent “double-line” teaching, that is, mixture of online and offline teaching, are practically separate most of the time. Compared with the mixed online and offline teaching, the integrated online and offline teaching emphasizes integration or incorporation, which are the fundamental characteristics and core pursuit of the integrated teaching (Li, 2020). On No.1 Middle School of Zhengzhou Distance Education Campus, the online and offline teaching are fully integrated. Lecture teachers of the live broadcasting classes formulate teaching plans, conduct classroom teaching, and assign after-class tasks according to the curriculum and implementation plan of No.1 Middle School of Zhengzhou; Remote terminal class teachers organize classes, tutoring, and Q & A, give feedback to lecturers, and discuss online with them to solve problems. The community has uniform examinations and assessments, and share teaching assessment results.

## Interactive Teaching Reforms

Teaching reform is a multi-agent behavior involving teachers, schools, and society. In the educational community, No.1 Middle School of Zhengzhou is committed to providing practical and pertinent assistance for the disadvantaged schools in their teaching reforms and helps them convert extrinsic educational resources into intrinsic strengths. Schools in the community cooperate with one another in curriculum and teaching reform and share experience to improve teaching quality.

## Results of the Educational Community and Reflections

In this educational community supported by Internet plus Satellite live broadcasting, the educational resource distribution is focused on transmission of high-quality educational resources of advantaged schools to disadvantaged schools. Our goal is that students in the region can share educational resources equally and fairly.

After years of exploration, No.1 Middle School of Zhengzhou has created an effective model of educational resources sharing, well known for its practice of “one provincial key school helping other less advantaged school.” A common curriculum system of the community is created by remote collaborative lesson preparation, teacher-tutor coordinated teaching and uniform assessment standards. Meanwhile, a channel of teachers’ professional development is built by systemized activities such as joint online lesson preparation, offline teaching research seminars, presentation of excellent classes and high-level competence training. With efficient and regionwide resource sharing, a new educational ecology of multi-dimensional cooperation, mutual assistance and promotion has been formed.

In addition, the technology of Internet plus satellite live broadcasting has enabled the school to formulate a working model of remote collaborative education. The major components of this model are integrated implementation of curriculum, teaching and assessment. Through integration of curriculum and teaching materials, the wide coverage of curriculum resources is realized; the working mechanism of combining teaching and research and the teacher-tutor teaching mode routinize the sharing of teaching resources; uniform assessment standards are reached through uniform test questions, examination organization, marking standards, and assessment feedback.

Using these two models, the educational community has greatly promoted the improvement of the overall educational quality and equity in the region and the development of No.1 Middle School of Zhengzhou.

First, the efficient model of educational resource sharing in the community has great advantage in regional poverty alleviation and has achieved good results. Since 2006, the community's educational resources have benefited 82 schools in 70 counties and cities in Henan Province, including 19 national key counties and 8 provincial key counties for poverty alleviation work.

Second, the construction of the educational community plays important roles in improving the educational level of numerous schools with weak foundation and promoting the equalization of education in the region. Since 2006, the number of classes and online teachers and students in the community has continued to grow every year. By 2018, there had been a cumulative number of 1,835 online classes, 119,275 students, and 11,010 teachers in this community, and 90% of these students came from remote counties and rural high schools.

Third, the two models help improve the learning quality of students in the region and their comprehensive competence. The school culture and learning methods of No.1 Middle School of Zhengzhou have gained wide acceptance among students in the remote terminal schools. After three years of learning and training in the community, they have made great progress in learning ability, thinking skills, and academic achievements.

Fourth, the two models help promote teachers' professional development and improve teachers' teaching and research level. Teachers of the live broadcasting classes have set extremely high standards for themselves because of their special roles. In addition, hosting remote collaborative teaching and research every week and participating in teaching seminars encourage them to raise their professional levels. Teachers selected as live broadcasting lecturers face a larger teaching platform and stricter assessments, which motivates them to make continuous progress. As a result, many of them have become municipal and provincial teaching role models. The tutors of the remote terminal classes have improved their professional competence and teaching and research level greatly by working alongside teachers of live broadcasting classes. Young teachers have attained particularly rapid growth in the community. More than 80% of those teachers with less than five years of teaching experience have received commendations in the official selection of high-quality courses, subject research, or theses after having

worked and trained in the community. This has further stimulated overall progress of teachers in remote terminal schools.

Finally, the practice of educational community stimulates education and teaching reform aiming at developing students' comprehensive competence. To improve the results of classroom teaching and cultivate students' high order thinking abilities, No.1 Middle School of Zhengzhou initiated a teaching reform named self-directed learning in the community in 2009. Self-directed learning requires students to use their initiative to find, analyze and solve problems in study and to understand the learning process and key elements of knowledge through inquiries. It is a counter to the traditional teacher-dominated teaching model. Teachers and students at all schools in the community participated actively in this reform and gave effective feedback so that the reform led by No.1 Middle School of Zhengzhou could be conducted smoothly and received good results in the community. Self-directed learning fundamentally changes students' learning habits and skills. The Theory and Practice of Self-Directed Learning, a study based on the reform won the first prize of Henan Basic Education Teaching Achievement Award in 2014. Zhengzhou No. 1 High School, with its effort to build the educational community, is well recognized by other schools, students, parents, and society.

Despite the achievements, the school is reflecting on how to make better use of information technology and the educational community to make more contributions to equalization of education in the region. Several suggestions are proposed for future experiment and exploration. Technically, a switching function should be added to live broadcasting so that real-time screen switching can be conducted in live broadcasting and students at remote terminal schools have the opportunity to ask questions and discuss with lecturers online; The online tutoring and Q & A platform should be improved to ensure that teachers can provide effective tutoring for students in remote rural areas in time. To further improve educational quality of the schools in the community, the contents of the live broadcasting classes should be expanded to cover more subjects and activities such as morality, art festival, club activities and school-opening ceremony. Moreover, new initiatives should be introduced to enrich the practice of resource sharing. For example, students should be encouraged to make personal friends in other schools in the community and exchange visits to enhance mutual understanding. All in all, our vision is to build a high-tech and sustainable educational community with the goal of common development of all students.

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# The Exploration of the Food Education Program in Primary and Secondary Schools

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**Abstract:** Nowadays, unhealthy dietary habits, insufficient food knowledge, and lack of manual skills are typical issues among primary and secondary school students in China. To help students build up a strong constitution and life wisdom, Weifang Hansheng School of Shandong developed a food education course. This paper expounds on the course framework, contents of food education textbooks and the measures to implement the course.

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## **Introduction**

**F**OOD education refers to the education of food and food-related knowledge for students from their early childhood, with extension of this education to the cultivation of students' outlook on life. Specifically, there are two components in this education. One is diet education on food nutrition and dietary habits; the other is value and ability education, to improve students' overall competence by engaging them in the process of food production, from farmland to table.

Since 1990s, food education has gained in popularity in many countries, where food education programs have been promoted through legislation, curriculum, and national campaigns. Japan promulgated the Basic Law on Food Education and the basic plan for promoting food education in 2005, which has significantly helped the development of food related industries, improved the protection of traditional food culture, and increased the knowledge of some lifestyle-related diseases (Miyoshi et al., 2012). In the UK, education of food and agriculture were introduced into curriculum so that students can learn how to grow, process, and cook their own food in school (Ensaff et al., 2015). America witnessed in the last few decades a proliferation of garden-based nutrition-education programs for children and adolescents aiming at prompting healthy and balanced dietary habits (Robinson-O'brien et al., 2009).

In China, the idea of food education was first raised by Professor Li of China Agricultural University in 2006, who believed it necessary to promote food education in addition to moral, intellectual, and physical education given the public concerns with modern lifestyle-related diseases, food safety, food production, and environment (Li, 2010). However, at the level of the state, policymaking on food education is not at the top of the agenda; There are almost no food related courses or teaching materials for reference in the primary and secondary school curriculum (Zhu et al., 2019; Guo, 2020).

Weifang Hansheng School of Shandong started to develop a food education course in 2015. After six years of research and practice, it succeeded in creating the course to help students develop healthy eating habits and improve their practical ability. This paper elaborates on the framework of food education course, the design of twelve-year textbooks, and the implementation patterns.

## **The Framework of the Food Education Course**

In September 2018, the school surveyed 1850 students on their dietary behavior and found that 82.7% of students like fried foods (such as KFC) and carbonated drinks while take in few vegetables, which leads to a general decline of students' constitution. The survey results also show that students lack dietary etiquette as well as labor skills (Chen, 2017). Findings of this survey indicate that food education should address not only students' dietary habits and nutrition balance, but also their overall dietary behavior including eating manners and food related knowledge learning.

## ***Objectives of the Food Education Course***

According to student development needs and existing problems, the school has set an overall objective of the food education course, that is, to help students build up a strong constitution and life wisdom. Specifically, it can be divided into general objectives and phased objectives.

## General Objectives

*Theoretical objective:* Students acquire basic knowledge in food planting, food processing, and nutritional balance, and reach their own understanding of Chinese and Western food culture.

*Practical objective:* Students learn how to operate farming, prepare food, plan balanced menu, and other related skills. Each of them knows how to grow at least two crops and cook at least two kinds of food. In preparing food, they must pay attention to the sufficient inclusion of vegetables and be careful not to waste any ingredients.

*Emotional objective:* Students learn to respect workers and their work results and experience work enjoyment in practical activities.

## Phased Objectives

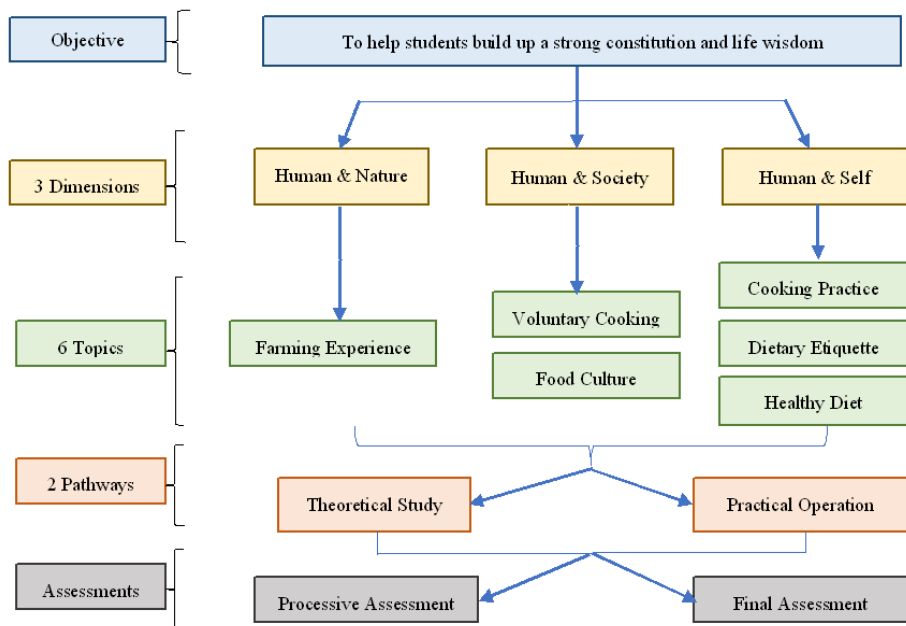
First-phase objective: Students fulfil basic contents of the course (farming, cooking, healthy diet, table manners and food culture, etc.). They can skillfully use common dining tools and show good manners in dealing with food; they can briefly describe each activity and their reflections in their own words; They show respect to the work results of others by saving food.

Second-phase objective: Students can distinguish various foods, explain the nutritional composition of different foods, and present the benefits of good eating habits in their own words; They can fulfil tasks in farming, cooking and voluntary cooking to standards; They acquire abundant knowledge in dietary etiquette and food culture. Detailed reports are required to record the process of food education and the results.

## ***The Framework of the Food Education Course Based on its Objectives***

As shown in the framework (see **Figure 1**), aiming at “helping students build up a strong constitution and life wisdom”, this course covers three dimensions (human and nature, human and society, human and self) and six topics (farming experience, cooking practice, voluntary cooking, dietary etiquette, healthy diet, food culture). The school attempts to fully realize the objectives of the course through the two implementation pathways (theoretical study and practical operation) and the two assessment methods (process assessment and final assessment).

Food culture sessions encompass food stories, regional dietary customs, food festivals, tea and alcohol history and cultural differences between China and the West. Healthy diet sessions cover food safety, dietary nutrition, eating habits, etc. Dietary eti-



**Figure 1. The Framework of the Food Education Course.**

quette sessions deal with pre-meal preparation, dinnerware setting and table manners. Farming experience sessions include agricultural solar terms, farming tool operation, characteristics of crops, farming skills, soil improvement, agricultural science and technology. Cooking practice sessions includes ingredient identification and processing, food cooking, the use and maintenance of cooking ware, sanitation and cleaning. In voluntary cooking sessions, students take turns to help food education teachers with their full-time work (from 5 am. To 6 pm.) in the school kitchen.

The six segments of the course point to clear associations, to be specific, associations between farming experience and nature, between voluntary cooking and respect to physical work, between food culture and cultural understanding, between cooking practice and skill acquisition, between dietary etiquette and civilized manners, between healthy diet and eating habits.

## Food Education Textbooks

The framework of the food education course is integrated with compulsory subject curriculum, life education, and labor education. Traditional culture such as solar terms, traditional festivals, food culture and farming culture is also incorporated into the food education course. After nine revisions, the school finally managed to compile a set of food education textbooks for students of 12 grades. The six topics in the framework run through the three stages of primary school, junior secondary school and senior second-

**Table 1. Contents of the Food Education Textbook for Primary Schools.**

<b>Grades</b>	<b>Chapters</b>	<b>Sections</b>
Grade 1	Chapter 1: Color elves in the Food Kingdom	
	Chapter 2: Adventures in the Food Kingdom	
	Chapter 3: Mobilization in Food Kingdom	
Grade 2	Chapter 1: Food varieties	1. Daily intake of whole grains 2. Daily intake of vegetables 3. Daily intake of fruit
	Chapter 2: Little dieticians	1. Food sanitation 2. Balanced diet 3. Wise eaters
	Chapter 3: Dining rules	1. Dining etiquette 2. Saving food with gratitude
Grade 3	Chapter 1: Dietary habits	1. Balanced menu without waste 2. Say no to junk food
	Chapter 2: Self-reliance	1. A decision maker at home and school 2. Gratitude to food providers
	Chapter 3: Etiquette and culture	1. Table manners 2. Art from food
Grades 4	Chapter 1: Balanced nutrition	1. My story of nutrition 2. My story of food 3. My story of sports
	Chapter 2: Food safety	1. Basic knowledge of food safety 2. Prevention of diseases 3. Harm of junk food
	Chapter 3: Good dietary behavior	1. Necessity of both meat and vegetables 2. Follow healthy eating habits 3. A decision maker of this week
Grade 5	Chapter 1: Health from food	1. Nutrients in food 2. A little dietician
	Chapter 2: Good manners at table	1. Chopsticks VS forks and knives 2. No leftover 3. Environment protectors
	Chapter 3: Food-related festivals	1. Dumplings, symbols of good fortune 2. Rice dumplings, symbols of reunion 3. Moon cakes, symbols of harmony
Chapter 6	Chapter 1: Food guidelines for adolescents	1. Food for adolescents 2. Inappropriate eating behaviors 3. How to build fitness
	Chapter 2: Food and ecology	1. Are they edible? 2. Growing plants
	Chapter 3: Food culture appreciation	1. Traditional Chinese food 2. Comparison between Chinese and Western food 3. Food culture all over the world

ary school and are emphasized in different ways in each stage. The first graders of the primary school are guided to obtain a preliminary understanding of food through stories from picture books; For the second to sixth graders of primary school, knowledge of common food and healthy dietary habits are emphasized; In Junior secondary school, the focus is on students' farming experience, dietary etiquette, and food culture knowledge; The senior secondary school students are required to focus on food processing and storage, food safety, and the comparison of Chinese and Western food culture. The following is contents of the food education textbook for primary schools (see **Table 1**).

## **Integrative Implementation Patterns**

### ***School, Family, and Community Cooperation***

In the food education cooperation, the school plays a leading role as it can make the best of classroom teaching and guide on-campus and off-campus practice. Parents can serve as role models in educating their children on healthy diet and sound eating habits. To give full play to the role of parents, the parent school is set up to hold food education related activities for them. Parents are invited to participate in food festival, harvest festival and cooking festival alongside children. To combine community resources, five practice bases of food education are selected as locations for students to observe and practice food production in, and nutrition experts are invited to provide students with scientific nutrition education.

### ***Integration of Implementation Pathways***

Theoretical contents of food education: Each grade is provided with theoretical sessions in food education course. Through theoretical learning on the six topics (farming experience, cooking practice, voluntary cooking, dietary etiquette, healthy diet, food culture) in class, students fully understand the value, practical methods and dos and don'ts of the contents to ensure ideal results of practice.

Practical operation: All students take turns to undergo the practical sessions on the six topics of the food education course to enhance their living skills and build up wisdom in practice.

Emotional experience: Students achieve self-education and emotional sublimation through self-reflection and evaluation in theoretical and practical learning.

The food education course is conducted by integrating theory and practice and penetrated by emotional experience. The basic procedure is learning, practice, and expression, in which practice is led by theory, theory is proved by practice, and both enrich emotional experience.

### ***Multiple Locations for Food Education***

**Table 2. Assessment Records of Cooking Practice Sessions**

The first level indexes	The second level indexes	Assessment standards	Self-assessment ☆☆☆	Group's assessment ☆☆☆	Teachers' assessment ☆☆☆
Knowledge	Food knowledge	<p>☆☆: able to identify at least 6 vegetables.</p> <p>☆☆☆: able to categorize foods.</p> <p>☆☆☆☆: knowing features of at least 3 kinds of food.</p>			
	Kitchen ware knowledge	<p>☆☆: able to name at least 2 kitchen tools.</p> <p>☆☆☆: knowing characteristics of at least 2 kitchen tools.</p> <p>☆☆☆☆: knowing the usage and dos and don'ts of at least 3 kitchen tools.</p>			
	Cooking knowledge	<p>☆☆: able to name at least 2 dishes.</p> <p>☆☆☆: able to name the ingredients of at least one dish.</p> <p>☆☆☆☆: able to describe cooking method and cooking steps of at least one dish.</p>			
Practice	Cooking	<p>☆☆: able to name at least 5 dishes.</p> <p>☆☆☆: able to name the ingredients of at least 2 dishes.</p> <p>☆☆☆☆: able to complete the cooking of at least one dish.</p>			
	Putting Kitchen Items in order	<p>☆☆: cleaning kitchen ware after use.</p> <p>☆☆☆: putting away kitchen items.</p> <p>☆☆☆☆: tidying up worktop and clean the floor.</p>			
Reflection	Awareness of saving food	<p>☆☆: No waste of food in cooking, eating up dishes cooked in school kitchen.</p> <p>☆☆☆: No waste of food in dining, taking an appropriate amount of food each time.</p> <p>☆☆☆☆: aware of the importance of food, eating up in each meal.</p>			

Locations of food education include classroom, dining hall, farming base, restaurants, which means the farm is school, the dining hall is classroom, and dining is education. Professional cooking classrooms were built, and 3 mu of ground plantation and 12 Mu of roof planting area opened, to provide space for students to experience the whole process of seed selection, sowing, cultivating, harvest, cooking and sales.

## ***Multiple Subject Integration***

The school effectively integrates food education with subjects such as biology, geography, science, sports, Art, and morality & the rule of law as well as with labor education and traditional culture education. Apart from one scheduled session every week, food education is incorporated into classroom teaching of other related subjects in terms of time investment. Moreover, the food education course relates to extracurriculum activities such as food festival, rice dumpling lesson at Dragon Boat Festival, winter solstice dumpling lesson, mid-autumn moon cake lesson, and other winter and summer vacation activities (for example, “being family CEO this week” and family civilization course).

## ***Multiple Assessment Forms***

The food education course emphasizes processive assessment. The final results include self-assessment (70%), group’s assessment (20%), teachers’ assessment (10%). The assessment is carried out in three dimensions: Knowledge, practice, and reflection. Detailed assessment criteria are designed for each dimension, and results are graded in the number of (see **Table 2.**).

The implementation procedure of the food education course is presented as follows, using cooking practice sessions as an example.

### *(i) The Objective of Cooking Practice Sessions*

Students can name the basic nutrients in at least five common foods and know how to cook them; During these sessions, they learn to cook at least one dish, create a new recipe, and make a new dish on this recipe for their family. Participation in group work is also required to cultivate students’ teamwork spirit.

### *(ii) Procedure for cooking practice sessions*

#### *a. Kitchen Uniform*

Under the teacher’s guidance, the students dress themselves in kitchen uniforms and follow the order in the kitchen. The tutors help take photos of them.

#### *b. Content Introduction*

Food education teachers explain the main content and operation of this class, and let students watch the video of cooking practice.

#### *c. Cooking Practice*

Students practice cooking in groups according to the steps shown in the video.

#### *d. Food Sampling*

The prepared dishes are photographed with the “cooks”. No scrambling is allowed in sampling the food.

*e. Cleaning Up*

Uniforms should be stacked and placed as required; Kitchen ware should be cleaned and put away and the worktop and ground cleaned.

*f. Result Checking*

The teacher checks on the whole process, keep records and report to the supervisor of the grade in time.

*(iii) Assessment*

Processive assessment is used to assess students' performance in cooking practice. The results include self-assessment (70%), group's assessment (20%), teachers' assessment (10%).

## **The Outcomes of Food Education in Weifang Hansheng School**

In the 6-year practice, the food education program has proved to be significantly effective in improving students' food knowledge and dietary behavior. Students' dietary habits become healthier and their constitution stronger. The rate of breakfast skipping is lowered from 29.4% to 1.7%; The number of students with food fussiness decreases by 28.6%; Students show willingness to give up junk food and carbonated drinks. Moreover, students' dietary manners have improved remarkably, which is reflected in their increased awareness of queuing up to take meals, keeping quiet when eating, and taking appropriate amounts of food to avoid waste.

In addition, the school has built a professional team of food education staff. They have been well motivated by the school culture of curriculum research and creation in developing the food education course.

The joint efforts of students and teachers in the development of the food education course have helped raise the school's profile. Numerous media have conducted exclusive interviews and special reports on the food education program of our school, and a total of 16 schools in Yunnan, Jiangsu and Shandong Province have referenced the implementation patterns of the school's food education course. The school took part in research on key issues of national nutrition and food security, one of the key projects of the Chinese Academy of Sciences and became a national base of food nutrition education. It was invited to participate in National Campus Meals Conference, China education science forum and China green agriculture and food nutrition summit forum. All the academic involvement help spread the school's experience in food education and motivate the school to strengthen its research and development in this field.

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