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Marginalised Students' Funds of Knowledge in Teaching and Learning Science: A Systematic Literature Review

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Abstract

Funds of knowledge refer to the historically accumulated and culturally developed bodies of knowledge and skills essential for household and individual functioning and well-being. Teachers face students from different backgrounds in the classroom. In order to provide the best possible education for all the students in a classroom, teaching practices must reflect an authentic sense of caring for a child in a way that recognises the importance of the utilisation of marginalised students' fund of knowledge. Hence, reviewing existing literature systematically is very important for finding the gaps in using marginalised students' funds of knowledge in science teaching and learning. A systematic Literature Review (SLR) is conducted to identify the type of funds of knowledge that can be used in science teaching and learning processes. Out of 321 articles identified from Scopus and Web of Science (WoS) databases, 28 articles were selected for the systematic review process. The finding of the analysis shows nine types of funds of knowledge that can be used in teaching and learning science, particularly for marginalised students. This research and its finding are expected to provide insight and information on the type of funds of knowledge for marginalised students that can be utilised in science education and contribute to the improved quality of science education in general.

Keywords: funds of knowledge, marginalised, teaching, science

1. Introduction

The educational and achievement gap between urban and rural students in Malaysia is narrowing from year to year (MOE, 2019). Equity and equal access to quality education are highlighted in the Sustainability Development Goal 4.0 (SDG 4.0). Hence the fight to give equal rights to all students through democratisation must continue to achieve equity in education. This will enable and empower rural students or students from minority groups in this country to compete with urban students in education, and subsequently produce more professionals in the fields of Science and Technology to face the current Industrial Revolution 4.0 and assist Malaysia in achieving the status of a developed nation. Although various initiatives have been undertaken by the government, such as internet access facilities, infrastructure, equipment, teacher professionalism and so on to overcome the achievement gap between urban and rural students, some factors still grip rural students in highlighting their achievements, especially in science subjects.

The wealth of knowledge, or funds of knowledge, are skills and knowledge that have been developed historically and culturally to enable individuals or households to function in a particular culture. The integration of funds of knowledge into classroom activities will create a richer and higher learning experience for students. (Moll et al., 1992). The teaching of STEM subjects such as Physics by utilising the funds of knowledge for students will be able to attract interest, motivation, curiosity and the inquiry process among students throughout the teaching and learning process. The use of funds of knowledge in teaching can reduce the gap between school and home by applying the knowledge and skills students acquire in their families and communities, and thus can support academic learning (González et al., 2005; Hogg, 2011). In addition, it can also help students find meaning when learning Science content and help them relate it to experience. This, in turn, could provide clarity and encourage the retention of knowledge learned.

Llopart et al. (2018), in "Teachers 'perceptions of the benefits, limitations, and areas for improvement of the funds of knowledge approach", stated that one of the challenges in terms of pedagogy is applying students' funds of knowledge within the curriculum and teaching practices. In today's world of education, it is very important to take the funds of knowledge into account when designing the curriculum and lesson for a subject, especially subjects that involve abstract and difficult concepts such as Science. By incorporating and applying students' funds of knowledge, especially in the case of marginalised and minority groups of students, teachers can make them feel part of the learning process. Apart from that, students can also acquire new knowledge and skills in a very meaningful way if they can relate it to their own experience or background culture.

2. Literature Review

In accordance with the Malaysian Education Development Blueprint (PPPM, 2013), the first shift, "*anjakan*", among the 11 shifts listed in the blueprint, relates to providing equal access to an international standard of quality education. Equity can be observed by giving equal access to education to all students in Malaysia and this will help make education an enabler of social mobility by ensuring that students from low-income families also have the opportunity to get higher education and further improve their socio-economic status later on in their life. In addition, five system aspirations were also introduced, namely access, quality, equity, unity and efficiency. Through the aspirations of the equity system, the government intends to reduce the achievement gap between urban and rural students, as well as the socioeconomic level and achievement between genders by up to 50% by 2020 (PPPM, 2013). Therefore, it is clear that Malaysia places great emphasis on equality of access to education, as well as equity in education, to ensure that all students have the opportunity to study at a higher level.

According to Meor and Hatimah (2010), teaching and learning science involves abstract science concepts and requires a high level of basic cognitive knowledge to understand those concepts well in order for them to become long-term memories for each student. Mulhall et al. (2001) also agree that concepts in science, technology, as well as engineering or STEM, are often abstract and difficult to understand for most students. Students' interest and achievement in science will increase if the content of science is relevant to the reality of the student's environment and background. According to Barton and Yang (2000), the content of science taught in schools is often irrelevant to the lives of students. Hence, this will definitely affect the interest and achievement of students, especially among the marginalised groups of students, such as students that come from low-income families or from different ethnic backgrounds or cultures. Brickhouse et al. (2000) support this by stating that if students do not feel a connection or union with science, then Science will not be part of the student's identity, and they will feel less interested in interacting with science in the future. Therefore, to encourage a deep interest in the learning of Science, Genzuk (1999) suggested integrating students' life experiences, cultural beliefs and students' historical knowledge (knowledge treasures) into the teaching of science.

This approach, known as funds of knowledge or FoK, originated in Tucson, Arizona, USA, in the early 1980s. The term 'funds of knowledge' is derived from a study conducted by Valez-Ibanez and Greenberg in 1983 on the U.S.-Mexico border for families (households) against changes in social and economic systems (Llopart & Esteban-Guitart, 2018). The funds of knowledge can be summarised as the knowledge and skills acquired by individuals as a result of interactions with friends, family, and community, as well as local history and culture. According to Moll et al. (1992), funds of knowledge refer to a group of historically accumulated and culturally developed knowledge and skills that are important to the functioning and well-being of a household or individual. The concept of knowledge treasures also refers to the various activities found in the daily operations of the household and the knowledge involved in carrying out those tasks (Greenberg & Moll, 1990).

The funds of knowledge can be utilised in the education of science subjects, especially in improving the understanding of concepts among students. According to Mejia and Lopez (2015), previous studies have suggested that when funds of knowledge are incorporated into the science curriculum, students are more engaged and often develop a richer understanding of scientific concepts. The studies of Barton and Tan (2009) and Moje et al. (2004) showed that the experiences of marginalised students while working outside the home, indoors, with popular culture, or with health etc., is a generative platform that forms the basis of engagement for more socially relevant scientific teaching.

Cultural and social interactions influence students ‘cognitive processes and their sense of belonging and identity. Students may avoid building scientific knowledge or align themselves only with scientific knowledge that does not interfere with their daily life experiences (Aikenhead & Jegede, 1999). Students possess a set of knowledge, skills and practices directly related to STEM, and teachers can use those funds of knowledge as an instrument to initiate conversations that help students engage in Science or STEM (Meijia & Lopez, 2015). A study conducted by Mejia et al. (2014) showed that the funds of knowledge of students who are often marginalised have the potential to improve their engineering design thinking. Moje et al. (2004) identified that there are four main sources of knowledge related to science, namely family, community, peers, and popular culture.

The funds of knowledge of students are many and varied because students are actively involved in various activities in their environment (Moll et al., 1992). Students who develop meaningful contexts for absorbing new information based on their own experiences can also improve their thinking and problem-solving skills (Michaels, 1981). Fusco (2001) claims that students are interested in learning Science when it comes from their own curiosity, interest and experience. When teachers do not link the sources of students' funds of knowledge, learning in the classroom tends to be less transformative and solicits less student engagement (Moll et al., 1992). Therefore, teachers should create a classroom environment that allows students to engage in a variety of situations, while teachers incorporate student experiences as part of science learning (Fusco, 2001). Mills et al. (2018) stated that students are able to make connections between their daily funds of knowledge with scientific inquiry. All of these approaches in the teaching and learning of science will certainly boost the quality and achievement of science among students, particularly students from marginalised groups.

3. Method

The focus of this research is the funds of knowledge of the marginalised students that can be used and integrated into Science teaching and education. The process used to find out and discuss the topic is a systematic literature review (SLR). Through the systematic review process, the researcher can show that the study to be done is well-founded and identifies gaps and directions that need to be addressed in future studies.

SLR identifies, evaluates, interprets and analyses the existing research papers, articles, and research findings in relation to the research questions. The main purpose of conducting a SLR is to construct a general vision, gather evidence of the research questions, and give a summary of the literature. In this study, SLR was conducted to identify, evaluate, interpret and analyse the available research findings to address the research question on the funds of knowledge for marginalised students to be used in science teaching and learning.

This study contains four steps, which are: identification, screening, eligibility and data analysis. Before a systematic review is conducted, the researcher needs to list the research questions in detail. The detailed research questions are:

1) What are the funds of knowledge for marginalised students that can be used in the teaching and learning of science?

2) What are the characteristics of funds of knowledge for marginalised students that can be used in science classrooms?

3.1 Identification Process

The first step of this SLR started with the identification process. The keywords and search string are identified based on the research question.

Table 1. The search string used for the systematic literature review process

Database	**Keywords used**
Scopus	TITLE-ABS-KEY ((“funds of knowledge” OR “Culturally relevant” OR “sociocultural” OR “family’s practices”) AND (“marginalised” OR “underserved” OR “minority”) AND (“science education” OR “STEM” OR “science teaching”))
Web of Science	TS = ((“funds of knowledge” OR “Culturally relevant” OR “sociocultural” OR “family’s practices”) AND (“marginalised” OR “underserved” OR “minority”) AND (“science education” OR “STEM” OR “science teaching”))

After identifying the keywords and search strings, manual searching of the related articles will be conducted in the online databases. For this study, the databases selected for the search process are *Scopus*, *Web of Science* (WoS) and several reliable databases (hand-picking process). The databases are chosen because all of these databases, such as Scopus and Web of Science, contain high-impact and indexing articles and journals.

3.2 Screening and Eligibility Process

3.2.1 Inclusion and Exclusion Criteria

The next phase of the SLR is considering some inclusion and exclusion criteria. A collection of articles was reviewed, and only journal articles that are written in English are chosen. The articles must include the applications of students’ funds of knowledge in the teaching and learning of Science subjects.

Exclusion criteria also are applied in this SLR. Papers written in other languages apart from English are excluded. Articles that do not follow the listed keywords are also excluded, even if they are related to the field of education or social science. Articles that fulfilled the inclusion and exclusion criteria are shortlisted and reviewed for final selection.

Table 2. Inclusion and exclusion criterion

Inclusion	Exclusion
Articles	Conference proceedings, book chapters, etc.
Available in full- text	Articles only available in summary.
Empirical articles	Editorials, review articles funds of knowledge.
Written in English	Articles written in other languages.
Articles focusing on funds of knowledge and science education.	
Published year (2013–2022)	

3.2.2 Systematic Literature Review's Flowchart

The screening and the selection of the articles searched in the chosen databases are conducted by using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The use of PRISMA will provide three advantages, namely: (1) clearly defining the research questions that require systematic research, (2) identifying criteria for inclusion or exclusion and (3) viewing a large database of scientific literature at a given time.

Based on PRISMA guidelines, out of the 321 research papers identified (2013 - 2022), only 28 research papers were used, after being screened and assessed for eligibility, for the report of this systematic review process.

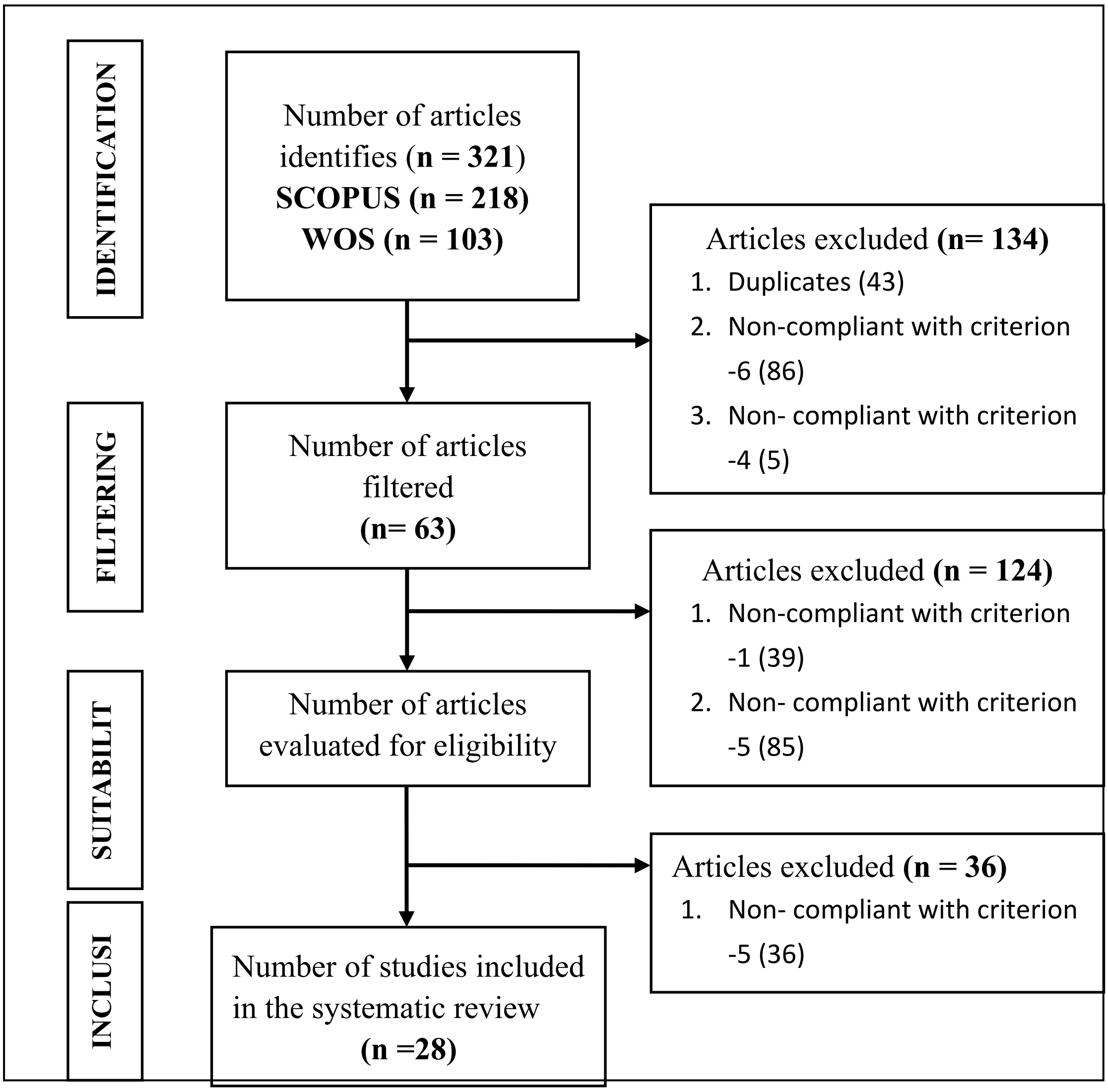

Figure 1. Systematic literature review (SLR) flowchart

Source: Adaptation from PRISMA 2020 flow diagram for new systematic reviews.

4. Results

Details of the findings of the 28 research papers and articles being analysed are in the appendix (Refer to Appendix A, Table A). A summary of the types of funds of knowledge mentioned in the research/articles is shown in Table 3 below:

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Table 3. Summary of type of Funds of Knowledge (FoK) used in the research/articles

No.	Author	Type of Funds of Knowledge (FoK)								
		Family	Cultural experiences	Community	Language	Daily activities	Economy	Cultural & Tradition	Technology & Artifacts	Cultural Object
1.	Alkholy et al. (2015)	/		/	/			/		
2.	Avery (2013)	/	/	/		/	/	/		
3.	Borgerding (2015)	/	/	/		/	/	/	/	/
4.	Brown & Crippen (2016)	/	/		/		/	/	/	
5.	Buxton et al. (2013)				/	/		/		
6.	Castaneda & Mejia. (2018)	/	/	/	/	/	/	/	/	
7.	Cruz et al. (2017)	/	/	/			/	/		
8.	De Beer. (2016)		/				/	/	/	/
9.	Goethe & Colina. (2018)			/		/		/		/
10.	Hernandez. (2022)	/	/	/				/		
11.	Irish. (2017)		/			/			/	/
12.	Tolbert. (2019)		/	/	/			/		/
13.	Kim et al, (2021)	/		/				/		
14.	Steven et al. (2016)	/	/	/	/		/	/		
15.	Underwood & Mensah. (2018)		/		/			/		
16.	Nation & Duran. (2019)	/	/	/		/				
17.	Seiler (2013)	/	/		/		/	/		/
18.	Mills et al. (2019)	/	/		/	/		/	/	/
19.	Kermish-Allen et al. (2017)	/	/	/			/	/	/	
20.	Sparks et al. (2020)	/				/			/	
21.	Martinez et al. (2018)	/	/	/		/		/		/
22.	Jackson et al. (2016)	/	/	/	/		/	/		
23.	Zuckerman & Lo. (2016)	/		/	/			/		
24.	Laing & Guang (2021)		/	/			/		/	
25.	Mudaly (2018)	/	/	/			/	/		/
26.	Pang & Hill (2018)	/	/	/		/	/	/		/
27.	Musavi et al (2018)	/	/	/		/	/		/	
28.	Kier & Blanchard (2022)		/			/	/			/

There are nine main categories of funds of knowledge identified from this systematic literature review of 28 articles: family, community, language, cultural experiences, daily activities, economy, culture and traditions, technology and cultural artefacts.

4.1 Family & Community

Most of the funds of knowledge for marginalised students came from their families and the community they lived in. This type of knowledge can serve as funds of knowledge for learning science. Hernandez (2022) describes culturally relevant teaching as teaching that recognises the different cultures of the students in the classroom, including home environments and backgrounds. A teacher needs to modify and adapt their lessons to meet the needs of their students, based on their backgrounds and environments. In research by Alkholy et al. (2015), it was found that native students learned information about natural health products from their elders. This supports the important role of elders in the family and community as a source of scientific knowledge (Alkholy et al., 2015; Avery & Kassam, 2011).

Teachers need to offer students examples from outside of school to enhance the outcome of science teaching and learning. One of the ways is by inviting parents into the classroom. (Tan & Barton, 2010). For example, high school students in Maine, United States, interviewed local fishermen and documented the fishermen's knowledge and experience (Avery, 2013). Family-based field trips to places like factories or planetariums, organised by the school, can also have a ripple effect on the interest of their children, particularly in STEM fields (Steven et al., 2016).

Scientific content and knowledge can also be introduced to students by connecting them to some of the aspects of the community they live in. A teacher can construct a lesson on mutation, tests such as glucose tests or nutritional changes, when discussing diseases based on students' ethnicities, such as diabetes (Brown & Crippen, 2016; Goethe & Colina, 2018). Project-based learning to discuss environmental or health problems in students' communities is also a great way to get them actively involved in the lesson (Tolbert, 2019). Knowledge of how the local community prepared for hurricane season, monsoon season or other types of natural disasters can also be used when discussing science, for example, waves in physics (Liang & Guang, 2021).

4.2 Culture and Traditions

According to Seiler (2013), culture has been commonly used in science education research, especially to examine issues of equity for students that come from low-income families, and different racial or ethnic minority communities. When a teacher fails to understand students' culture and traditions, most of the time, they would not be able to gain the student's attention and interest, which eventually leads to drops in students' achievement in science subjects (Alkholy et al., 2015; Borgerding, 2016; Hernandez, 2022; Brown & Crippen, 2016; Seiler, 2013).

Students of colour or other minority and marginalised groups always bring their unique set of cultural experiences, values, assumptions, and worldviews to the classroom (Harding-DeKam, 2014; Nasir, 2002). In Bissell's research, he stated that there is a concern among local native and Aboriginal communities about engagement with Western science and some harbour a fear that it will lead to the loss of traditional values (Bissell, 2004). Teachers must provide opportunities for their students to relate scientific knowledge to something related to their own cultures, such as musical instruments or books (Goethe & Colina, 2018).

4.3 Culture Experiences and Daily Activities

There are many connections between students' daily practices and scientific concepts (Moje et al., 2004). According to Avery (2013), relating a new scientific concept or knowledge to students' cultural experiences and daily activities is very important in engaging them to participate more in a science lesson. For instance, students can relate their experience of working on a farm or ranch to acquire knowledge of science and engineering. Fishing or hunting activities, which some of the students participated in, are also a great way to learn about animals in science (Avery, 2013; Cruz et al., 2017). Some of the environments that these marginalised students live in might have some pollution or other problems, such as public transport issues. Teachers can incorporate science knowledge by engaging students to discuss these problems. Science contents such as chemical reactions or environmental sustainability can be introduced to them when discussing issues such as pollution and deforestation (Cruz et al., 2017; Goethe & Colina, 2018; Liang & Guang, 2021; Castaneda & Mejia, 2018).

Their daily activities, such as playtime and hobbies, can also be a great source to be used in teaching and learning science. According to Mills et al. (2019), children might be able to connect their activity of riding a bicycle to the law of motion in physics. Fireworks, fire, or even passing gas can be used to introduce the idea of an exothermic reaction in chemistry (Tolbert, 2019). Students' trips to museums are relevant to the learning of evolution theory. (Borgerding, 2018). Their out-of-school experience with foods from home can be used when discussing topics such as chemical reactions or the identification of substances (Irish, 2017). A teacher can also help them to relate science concepts and knowledge to technology such as solar panels, which are normally used for street lights and construction sites (Steven et al, 2016). According to Nation and Duran (2019), Zumba dance, which is a favourite dance of the Latin community, is often adopted by students in their research when presenting their ideas.

4.4 Language

Language no doubt plays a very important part in influencing students' interest in science. Studies have shown that students who speak different languages have difficulties in learning science subjects (Alkholy et al., 2015; Brown & Crippen, 2016; Selier, 2013; Moje et al., 2004). As an educator, we need to look into students' language as a set of funds of knowledge that we can capitalise on to increase the outcomes of Science learning, particularly among marginalised students. According to Alkholy et al. (2015), the school and Science teacher can provide a support system for students in learning Science through acknowledgement of their language and culture. Students normally used their own terms when drawing and labelling images or diagrams when constructing their definitions of scientific concepts (Brown & Crippen, 2016). Teachers should always encourage students to use their own words when drawing representations or writing definitions. This is exhibited by one of the teachers in Tolbert's research (Tolbert, 2019).

There are other ways of incorporating language in science teaching. The teacher can use songs to describe the contents. For example, young girls can modify a popular song to describe each of the bones in the skeletal system (Barton et al., 2008). Seiler (2013) also highlighted the use of students' way of speech or using skits to teach Science to students.

4.5 Intervention or Manipulation Fidelity

Economics activities for marginalised students can also be utilised to deliver science to students. In the article written by De Beer (2016), local industries, such as traditional leather tanning in the community that has been selected as a research population, could therefore serve as a very good introduction to endothermic reactions in Chemistry Education. Teachers can also teach other scientific concepts, such as sustainability in environmental protection. Students can be taught about the amount of carbon dioxide (CO_2) gas in the atmosphere and its relation to farming and agriculture activities in the local community (Liang & Guang, 2021).

4.6 Cultural Artefacts & Technology

Cultural artefacts like medicine, home appliances, traditional working tools, etc. exist in certain communities. They provide rich resources for teachers to use in delivering scientific content and concepts to students. When teachers can identify these funds of knowledge among their students, they will provide students with a very meaningful experience and a sense of belonging to the whole process of learning science. De Beer (2016) stated that artefacts such as calcium powder, skincare routines, a tribe's house or architecture, and a tribe's artwork and medicine could be used to teach science subjects like Chemistry and environmental sustainability. Besides that, food and recipes that have been passed down for generations in a minority group can be used to teach chemistry, like a chemical reaction (Goethe & Colina, 2018; Mills et al., 2019)

Teachers can also draw the interest of their students by relating scientific content to pop culture like *Hip-Hop*, TV shows, and movies (De Beer, 2016; Irish, 2017; Tolbert et al., 2019). For instance, a student drew *Pac-Man* as a representation of human white blood cells eating viruses that enter the human body. Tolbert et al. (2019) also noted that some of the students involved in their research like to use a theme, such as a cartoon character, when asked to present their ideas. Elmesky (2011) and Emdin (2010) both stated that the possibility of these minority students participating in science learning increases when conventional science classrooms are transformed to create opportunities for the expression of aspects of hip-hop and other creative domains.

Social media and other technologies can also be utilised to enhance the learning of science among marginalised students in school. According to Mills et al. (2019), students who engage in popular interactive media, such as multiplayer online games, exhibit and demonstrate scientific habits of mind. Online gaming and video games are a big part of local children's lives. According to Liang and Guang (2021), all of these virtual gaming worlds, which mirror the physical world, can be used to teach the laws and concepts of Physics to students. Teachers also need to understand how their students express their funds of knowledge before they can fully tap into the full potential of social media, such as Facebook and Instagram, for science teaching (Mills et al., 2019).

5. Discussion

Marginalised groups of students are less likely to pursue a higher level of education in science and are unlikely to pursue their careers in STEM (Goethe & Colina, 2018; Aikenhead, 2006). According to Cruz et al. (2017), the main reason this happens is that most of the intellectual, cultural, and social resources of these minority students are often overlooked and undervalued in education. Rural communities and minority groups are often perceived as ill-equipped to perform and be competitive, particularly in STEM fields (Schafft & Jackson, 2011).

Avery and Kassam (2011) stated in their research that rural students need to see the relevance of science in their daily lives. Alkholy et al. (2015) also acknowledged that by providing culturally relevant teaching, a teacher could enhance and improve the performance of these marginalised students in science subjects. Meanwhile, Moll and Diaz (1987), Vélez-lbáñez (1988), Vélez-lbáñez and Greenberg (1992), Moll et al. (1992), and Moll (2014) highlight the significant roles that families and networks of households can play in education. By understanding their funds of knowledge for the working class and underserved students, i.e., family, community, peer and popular culture, teachers will be able to choose the best possible pedagogy to deliver science (Moje et al., 2004).

There are nine main categories of funds of knowledge identified from this systematic literature review of 28 articles: family, community, language, cultural experiences, daily activities, economy, culture and traditions, technology and cultural artefacts. The pedagogy adopted when applying students' funds of knowledge is called culturally relevant pedagogy (CRP). According to Byrd (2016), by implementing CRP strategies and Culturally Relevant Pedagogy, we can reduce the academic achievement gap among students, thus helping to achieve equity in our classrooms.

6. Conclusion

Funds of knowledge have long been identified as important tools and resources to create a connection between students' culture and science education in schools. Numerous examples of research agreed that by utilising students' funds of knowledge through culturally relevant pedagogy, we could improve the achievement of students in science subjects, especially those who came from minority and marginalised groups. This, in turn, will reduce the educational gap that has existed, thus promoting equity in science education. By conducting all of the review processes, 9 categories of students' funds of knowledge have been identified. Apart from that, a research gap has also been identified. The lack of quantitative design research is noticeable among all 28 articles that were reviewed. Only five examples of research used a quantitative design and one of them is in the form of quasi-experimental research. Thus, a suggestion for future research in education is to conduct quasi-experimental research to test the usage of students' funds of knowledge and its effectiveness in enhancing students' performance in science subjects.

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Appendix A

Table A. Type of funds of knowledge, methodology mentioned in each article and research

No.	Author	Field	Methodology	Funds of knowledge
1.	Alkholy et al. (2015)	STEM	Quasi- Experimental Design • Pre & post test • Sample, n=11 (Uni students)	Language, Family, Community, ethnicity, Indigenous elders as co-educator, culture's values and traditions.
2.	Avery (2013)	Science Ed.	Qualitative Design • Documents/articles analysis	Hobbies; farming activities, fishing, hunting, environtment, local resources and economics' activities, cultures & family's history, native elders as co-educator.
3.	Borgerding (2015)	Biology	Qualitative Design • Interviews, field's note observation, evaluation tools.	Farming & Agriculture, electronics 'appliances, toys, religion, cultural experience, pop cultures, economy.
4.	Brown (2016)	Science Ed.	Mixed method Design • Field observation • Groups interviews	Race, language. Family's income, culture's background, cultural artifacts (medicine)
5.	Buxton et al. (2013)	Science Ed.	Longitudinal design • Interviews • Sample, n= 133	Language, ethnic's background, culture & traditions, daily activities and experience
6.	Castaneda & Mejia. (2018)	STEM	Qualitative Design • Documents analysis	Cultural knowledge, linguistics, culture & traditions, community, technology, economic's activities
7.	Cruz et al. (2017)	Education	Qualitative Design • Articles analysis • Interviews	Community, family, culture & traditions, economy, cultural experience
8.	De Beer. (2016)	Science Ed.	Qualitative Design • Document analysis	Economics activity, technology, artifacts, music, culture & traditions
9.	Goethe & Colina. (2018)	STEM	Qualitative design • Documents and articles analysis	Community, cultural, personal interest, food and recipe
10.	Hernandez. (2022)	Education	Qualitative design • Documents analysis • Interview (n= 20: US teachers)	Cultural experiences, values, children's worldviews, indigenous elder (family & community), home environment/ background.
11.	Irish. (2017)	Science Ed.	Qualitative design • Case study (n=3, US teachers)	Popular tv shows, daily experiences, gaming technologies, cultural experiences
12.	Tolbert. (2019)	Science Ed.	Qualitative design • Interviews • Field's observation	Cultural experiences such as firework and having flu, living environment, cultural artifacts, language.
13.	Kim et al, (2021)	STEM	Qualitative design • Interviews (n=6 – US Uni. Students)	Cultural background, family, community, indigenous elder as co-educator
14.	Steven et al. (2016)	STEM	Qualitative design • Case study • Survey	Native worldviews, language, cultural background, family, local industries, local environment, cultural experiences
15.	Underwood & Mensah. (2018)	Science Ed.	Qualitative design • Survey and interview (n = 66 teachers)	Language, cultural background, students worldviews.

16.	Nation & Duran. (2019)	STEM	Qualitative design • Field's observation • Interview	Environment, community, cultural experiences and activities, family
17.	Seiler (2013)	Science Ed	Qualitative design • Documents/articles analysis	Economics, family, ethnics belief and culture, street culture, way of speech, pop culture, language
18.	Mills et al. (2019)	Science Ed	Qualitative design • Document analysis • Interviews & Field's observation • (n = 75: teachers, community leaders, parents, students)	Cultural experiences, pop cultures, musics/movies, storytelling, language scaffolding, gaming technology, social media, foods, hobbies
19.	Kermish-Allen et al. (2017)	Science Ed	Mixed Method design • Interviews and fields observation • Quasi experimental • (n= 107: Students, teachers, community members)	Technology, cultural experiences, family traditions/activities, economic sector, community
20.	Sparks et al. (2020)	Bio. Tech.	Qualitative design • Documents/ articles analysis	Family, cultural activities, technology
21.	Martinez et al. (2018)	Science Ed.	Qualitative design • Interviews (n=5: students)	Family, cultural experience, daily activities, community, cultural & traditions, cultural artifacts such as objects at home.
22.	Jackson et al. (2016)	Science Ed	Quantitative design • Longitudinal survey • N=249 Uni. Students	Family, community, cultural & tradition, language, economics
23.	Zuckerman & Lo. (2016)	Science Ed	Qualitative design • Document analysis • Interviews (n = 29, students)	Family, community, cultural & traditions, language
24.	Laing & Guang (2021)	Physics Ed	Qualitative design • Documents/ articles analysis • Field's observations	Local geographical facts, gaming, local economics sector, public transportation's issue and problem.
25.	Mudaly (2018)	Education	Qualitative design • Survey (Open ended questionnaire) • N= 224, pre- service teachers.	Farming, cultural & tradition, cultural experiences, community, family, artifacts such as medicine.
26.	Pang & Hill (2018)	STEM	Qualitative design • Documents/ articles analysis	Medicine (artifacts), cultural & traditions, family, economic, daily activities, cultural experiences, technology
27.	Musavi et al (2018)	STEM	Mixed design • Field's observation • Survey • N= 88 (80-students; 8 teachers)	Community, family, economics activities, daily activities, cultural experiences, teachology
28.	Kier & Blanchard (2022)	STEM	Qualitative design • Case study • Interviews/ fields observation • N=4 (students)	Daily activites, play time, music, cultural artifacts such car, parent's job, cultural experiences (eg. Went to workshop and astronomy camp)

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