Empowering library and information science students as information literacy educators in librarianship professions: a study from Bangladesh

Md Arman Hossain
Faculty of Information Technology and Communication Sciences, Tampere University, Tampere, Finland and Department of Information Science and Library Management, University of Rajshahi, Rajshahi, Bangladesh, and

Eero Sormunen
Faculty of Information Technology and Communication Sciences, Tampere University, Tampere, Finland

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Abstract

Purpose – The purpose of this study is to develop a novel guided inquiry-based pedagogical practice embedded into regular library and information science (LIS) courses to improve LIS students' information literacy (IL) in a developing country.

Design/methodology/approach – A guided inquiry-based pedagogical practice for IL instruction was introduced and embedded into two regular courses in an LIS school. The effectiveness of the new approach was evaluated in a longitudinal pre-test- and post-test-based teaching intervention with a control group.

Findings – All aspects of IL skills improved among the students participating in the teaching intervention showcasing the benefits of the inquiry-based pedagogical practice. In addition, the students in the intervention group learned the course subject content more in depth than students in the control group. However, no consistent learning benefits were achieved in IL knowledge, and only sporadic associations were found between IL knowledge and skills.

Originality/value – This study breaks new ground in IL teaching intervention in LIS schools. To the best of the authors' knowledge, it is the first to apply an inquiry-based approach, embed teaching into more than one regular course, collect pre-test and post-test data to evaluate learning outcomes in IL knowledge and skills and control learning outcomes in subject contents.

Keywords Information literacy (IL), IL knowledge, IL skills, Guided inquiry, Library and information science, Developing country

Paper type Research paper

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1. Introduction

Librarians have enlarged their role as educators from library instruction to information literacy (IL) (Albrecht and Baron, 2002; Bewick and Corrall, 2010; Hodge, 2015; Stubbings and Franklin, 2006). However, their conceptions of IL have remained library-centred, emphasising the knowledge of information sources, skills of searching and normative evaluation of information (Julien *et al.*, 2018; Pattar and Kanamadi, 2010). Developing ideas and questions (to specify information needs) and using information sources have earned less attention. As a consequence of librarians' library-centred conception of IL, professional librarians may not understand the position of their trainees well in solving genuine information problems.

Library and information science (LIS) students learn IL theories in their schools (Derakhshan *et al.*, 2015; Inskip, 2015) and work as library professionals after graduation. Because LIS schools do not provide compulsory pedagogical training, LIS graduates struggle as library professionals to integrate IL into curricula (Moselen and Wang, 2014) and provide IL instructions (Albrecht and Baron, 2002; Hodge, 2015). Moreover, librarians have adopted traditional views about effective pedagogies during university studies. Librarian's pedagogical view is a serious problem, especially in developing countries where traditional lecture and teacher-centred pedagogical practices dominate (Bremner *et al.*, 2022). Practicing traditional pedagogies during their studies does not give students a professional avenue to apply pedagogical practices that have been shown to be most effective in IL teaching. Thus, library professionals often take a surface-level approach to teaching IL (Johnston and Webber, 2003).

Traditionally, LIS schools teach some IL components to their students (Hodge, 2015; Ishimura and Bartlett, 2009). However, the situation of IL training for LIS graduates in developing countries is different. For example, in Bangladesh, three public universities have incorporated a theoretical IL course into their undergraduate curricula but lack practical training modules to enhance students' actual IL skills. So far, only certain private university libraries in Bangladesh have arranged workshops and short training programmes on IL (Begum *et al.*, 2020; Shoeb, 2013). A growing trend is that more and more LIS graduates are recruited to academic libraries (Tabassum *et al.*, 2020). A typical task for academic librarians is to teach researchers and other academic personnel IL skills. Ahmed and Yesmin (2019) found an alarming competence gap: librarians working for academic libraries in Bangladesh possess insufficient information skills.

We aimed to develop a novel inquiry-based pedagogical practice embedded into regular courses to effectively improve the IL competences of LIS students. The study adopted a pre-test post-test control group design.

We focused on the following research questions:

RQ1. Do LIS students' information literacy competences improve by participating in a guided inquiry-based teaching intervention?

RQ2. Do LIS students learn subject content better through guided inquiry-based instructions?

RQ3. Are LIS students' IL skills associated with their IL knowledge?

This study was motivated by the observed gap in teaching IL competences to LIS students in the public universities of Bangladesh and other developing countries.

2. Pedagogical framework

The pedagogical ideas and designs of this study were based on social constructivism, which describes learning as a social process. Social constructivists believe that learners create their own knowledge through social interactions. Learning does not occur only within an

individual nor do external forces passively develop it (McMahon, 1997). Vygotsky's Zones of Proximal Development (ZPD) was developed on social constructivism, conceived as the difference between what learners can accomplish independently and what they can accomplish with the support of more knowledgeable others (MKO). He argued that with the support of MKO, learners have the potential to accomplish tasks that they cannot achieve alone (Vygotski and Cole, 1978). Learner-centred pedagogical methods are widely endorsed by social constructivists or socio-cultural theories arguing that people learn through interaction with others (Limberg *et al.*, 2012; Lonka *et al.*, 2018).

A new pedagogical practice, i.e. guided inquiry for information literacy (GIIL), was developed for this study to improve the IL competences of LIS students in a developing country. GIIL is a guided inquiry-based and learner-centred pedagogical practice informed by the guided inquiry design (GID) framework (Kuhlthau *et al.*, 2012). Inquiry-based learning is a well-documented learning approach in science education and related pedagogies (Allen, 2008; Buck *et al.*, 2008). Big6 (Eisenberg and Berkowitz, 1999) and GID (Kuhlthau *et al.*, 2012) are widely used inquiry-based pedagogical models to improve the IL of learners from elementary level to higher education. Big6 is an inquiry-based pedagogical approach to information problem-solving, comprising six major stages and two sub-stages. It relies upon critical thinking skills. The GID framework emphasises the importance of guidance during the inquiry process. To ensure deep learning and improved understanding, students need guidance and intervention at multiple phases of the inquiry-learning process. Likewise, in Vygotsky's ZPD (Vygotski and Cole, 1978; Kuhlthau, 2004) described the phases as Zones of Intervention.

3. Literature review

3.1 Embedding information literacy instructions in higher education

Curriculum integration of IL instructions has been advocated by many researchers (Salisbury and Sheridan, 2011; Skov *et al.*, 2022; Stubbings and Franklin, 2006) and international associations such as Association of College and Research Libraries (ACRL) (2000) and ANZIL (Bundy, 2004). In higher education, curriculum integration of IL instructions can occur at different levels, i.e. university level, faculty or school level, programme level, course level or class level. Integrating IL at the university or faculty level is a top-down approach that needs approval from the top academic body of the university or the faculty. Embedding IL instructions at the course or class level is a bottom-up approach that a course teacher can do by negotiating with the programme co-ordinator or the curriculum committee for the programme (Wang, 2013). Higher education institutions in many advanced countries took the top-down approach to embed IL instructions into their curricula (e.g. Kessinger, 2013; Salisbury and Sheridan, 2011). However, a bottom-up approach can be appropriate for universities where a top-down approach is challenging to achieve (Stubbings and Franklin, 2006). Bottom-up approaches can bring successful shreds of evidence for the universities' top academic bodies to take a top-down approach to integrate IL instructions into the curricula of all disciplines (Hossain and Sormunen, 2023).

In the top-down approach to integrating IL, universities embedded IL concepts into core learning outcomes of mandatory courses in undergraduate and post-graduate programmes (Asplund *et al.*, 2013; Johnson-Grau *et al.*, 2016). Students received both online (Sipilä *et al.*, 2019) and offline (Hulseberg and Versluis, 2017) IL instructions to improve their basic and general IL skills and knowledge and discipline-specific IL skills and knowledge throughout the programmes (Johnson-Grau *et al.*, 2016; Sipilä *et al.*, 2019). In the bottom-up approach, IL components were integrated into one or more regular courses (Bakermans and

Plotke, 2018), for example, research methods (Adams *et al.*, 2016; Hulseberg and Versluis, 2017; Marfleet *et al.*, 2005) and master's thesis seminar (Xiao and Traboulay, 2008).

3.1.1 Information literacy standards and frameworks. The ACRL approved the Information Literacy Competency Standards for Higher Education in 2000. The ACRL standards included IL standards, performance indicators and outcomes to guide higher education institutions in deploying IL concepts and skills into their curricula (ACRL, 2000). Furthermore, in 2016, ACRL adopted the Framework for Information Literacy for Higher Education. The framework suggests incorporating IL across curricula and provides a mechanism for guiding IL programmes in higher educational institutions. It promotes a deeper understanding of knowledge practices and dispositions a student should develop to be information literate. The framework includes six frames; each consists of a threshold concept for IL, a set of knowledge practices and a set of dispositions (ACRL, 2016). The subject experts identified threshold concepts for IL using the Delphi method (Townsend *et al.*, 2016). The knowledge practices demonstrate how learners can transform their understanding of these IL concepts, and the dispositions illustrate how the affective, attitudinal or valuing dimension of learning can be addressed.

3.1.2 Pedagogical methods for information literacy instruction. Embedding IL instruction into the curriculum is critical and requires following the university's lengthy academic and administrative processes. However, the keys to successful learning of IL skills and knowledge are the pedagogical methods, learning activities, learning contents and assessment methods. In many disciplines, the traditional lecture-based and teacher-centred pedagogical methods are challenged by learner-centred pedagogies (Haider and Sundin, 2022, p. 91; Lonka *et al.*, 2018, p. 51). Learner-centred active learning methods, for example, problem-based learning (PBL) (Dolničar *et al.*, 2017; Walton and Hepworth, 2011), inquiry-based learning (IBL) (Allen, 2008; Cleland and Walton, 2012; Tsunekage *et al.*, 2020) and project-based learning (Bakermans and Plotke, 2018) methods have been proven more effective than traditional lecture-based methods in improving IL competences.

3.2 Information literacy teaching interventions in library and information science schools

Some university libraries took the initiative of embedding IL into both the university's core curricula and disciplines' course curricula with the collaboration of academic staff (Stubbings and Franklin, 2006). Many studies were carried out on IL integration into the university's core curricula (Johnson-Grau *et al.*, 2016; Sipilä *et al.*, 2019) and various disciplines' course curricula (Adams *et al.*, 2016; Freeman and Lynd-Balta, 2010; Stubbings and Franklin, 2006; Wang, 2011). However, there was a scarcity of research on IL integration into LIS curricula (Hossain and Sormunen, 2023).

IL elements have long been taught in LIS schools (Baro, 2011; Ishimura and Bartlett, 2009; Julien, 2005), but only a few IL teaching interventions have been carried out in LIS schools (Hossain and Sormunen, 2023; Lamb, 2017; Pinto and Fernández-Pascual, 2019; Lamb, 2017) conducted a pre- and post-tests-based intervention that used online tutorials for LIS students to improve their IT knowledge. Students attended the post-tests for the sections where they scored less than 85% in the pre-tests. They were allowed to retake the post-tests multiple times until they scored 85% and above in all the sections. Therefore, the pre- and post-tests did not inform us evidently how effective the intervention was for the LIS students. Pinto and Fernández-Pascual (2019) conducted a pre-test- and post-test-based teaching intervention for LIS students in Spain through a content analysis course. Students' self-efficacy in IL and their beliefs in the importance of IL were measured before and after the teaching intervention. The intervention had a significant impact on students' self-efficacy and less on their belief in importance.

A short-term pre-test- and post-test-based teaching intervention with a control group tested a new pedagogical practice for IL teaching and learning in an LIS school in Bangladesh (Hossain

and Sormunen, 2023). A guided-inquiry-based (Kuhlthau *et al.*, 2012) pedagogical practice, GIIL, was developed to improve the IL of LIS students. The IL instructions were embedded into a fundamental compulsory course. In the IL knowledge post-test, the intervention group scored higher than the control group in overall IL knowledge and two of its subdomains, i.e. information searching and gathering, and understanding value of information (Hossain and Sormunen, 2023).

A limited number of studies have been carried out to improve the IL competences of LIS students. Although many researchers advocated and used curriculum-embedded IL instructions in many disciplines, it was not common in LIS schools (Hossain and Sormunen, 2023; Pinto and Fernández-Pascual, 2019). In LIS education, the effectiveness of teaching interventions was measured through pre-/post-tests of students' IL self-efficacy (Pinto and Fernández-Pascual, 2019) and IL knowledge (Hossain and Sormunen, 2023). In higher education, we lack longitudinal curriculum-embedded IL interventions in the LIS discipline that measure the intervention's effectiveness through IL knowledge and IL skills pre-tests and post-tests.

In conclusion, surprisingly, few studies have been done on IL teaching interventions in LIS schools. We lack teaching intervention studies where the development of IL competences is measured in a rigorous pre-test/post-test setting (cf. research question a). Also, an important question in embedded IL instruction – the interplay of learning IL competences and course subject contents - has remained a neglected research topic (cf. research question b). Furthermore, no attention has been given to IL knowledge and IL skills as the components of IL competences (cf. research question c). Thus, our research focuses on poorly covered areas of IL instruction in higher education, especially in LIS schools.

4. Methodology

This study adopted a positivist approach. In the positivist view, humans are rational individuals presided over by social laws, and their behaviour is learned through observation. Positivists believe that scientific methods can be used to study human issues whenever they are considered natural phenomena (Zandvanian and Daryapoor, 2013). The scientific method, in its pure form, involves experimentation to explore observations and answer questions. It is used to search for cause-and-effect relationships in nature. It provides explanations and makes predictions based on measurable outcomes (Kivunja and Kuyini, 2017). Thus, findings from scientific methods may be generalisable to other similar communities (Zandvanian and Daryapoor, 2013).

Experimental design (Price *et al.*, 2015) is increasingly recognised as a robust research design for educational research (Cash *et al.*, 2016). The pre-test–post-test control group design, the most recommended experimental research design (Campbell and Stanley, 2015), was used for this study. A teaching intervention was carried out using the pre-test–post-test control group design throughout two academic semesters to examine the effectiveness of a novel pedagogical practice for IL instructions. Instead of including a stand-alone IL course for first-year students, the present study embedded IL instructions into two regular compulsory courses. The pedagogical practice was tested through IL competences pre- and post-tests and a final written examination. The study was carried out in an LIS school at a public university in Bangladesh. All the bachelor first-year first-semester students (n = 76) participated voluntarily in a two-semester long pre-/post-tests-based teaching intervention, and about 43% of them were female. For this study, the participants were divided equally into intervention (n = 38) and control (n = 38) groups based on their pre-test scores.

4.1 Teaching intervention

The teaching intervention was carried out through two compulsory courses in the LIS school (Department of Information Science and Library Management) at the University of Rajshahi

in Bangladesh. The first course on "Introduction to Information Science and Library Management" took place during the first year first semester (January–March 2020), and the other on "Documentation and Information Retrieval" during the second year first semester (March–May 2022). The same group of students participated in both intervention courses. Due to the COVID-19 pandemic, the university cancelled contact teaching, so the students completed all their first year second semester studies online. The pedagogical practice required face-to-face courses to be tested through the teaching intervention. So, the second part of the intervention was postponed from the first year second semester to the second year first semester.

4.1.1 Guided inquiry for information literacy. A guided inquiry-based and learner-centred pedagogical practice, i.e. GIIL, was developed to improve the IL competences of LIS students in a developing country (Hossain and Sormunen, 2023). The pedagogical practice was informed by the GID framework (Kuhlthau *et al.*, 2012). Instead of traditional lecture-based instructions, GIIL allows students to learn the course contents through online inquiry, discussing the topics in small groups called learning circles and writing assignments. The course teachers provide short lectures on the course contents and encourage students to search the internet for information on the topic. Students evaluate the online information and select relevant and reliable information to complete their assignments. They discuss the topic in their learning circle and write a short essay. The teachers act as co-learners and guide and intervene only when necessary.

By attending the intervention courses, students were expected to:

(1) learn the course contents deeply; and

(2) develop their competences in:
- information searching and gathering through preliminary, exploratory, comprehensive and summary searches on the internet and library database;
- evaluating online information by assessing expertise, accuracy, currency, perspective and quality of information;
- source-based writing to create new knowledge by interpreting facts and organising ideas; and
- understanding the value of information by using gathered information responsibly and wisely.

4.2 Teaching modules for the intervention and the control group

4.2.1 Course 1. The first intervention course included seven modules. The intervention and the control group received separate instructions only for the first two modules. For the rest of the modules, both groups received lecture-based instructions. The intervention group was divided into nine learning circles of four to five students for this course. For modules 1 and 2, the intervention group attended a library session and five inquiry-based teaching sessions for each module and completed one collaborative and one solo writing assignment. The control group attended six traditional lecture-based contact sessions for each module and completed two solo writing assignments for the first two modules. Thus, to complete the first intervention course, the intervention group spent approximately 50 h, and the control group spent approximately 51 h (see Figure 1).

4.2.2 Course 2. The second course included five modules. The intervention group received GIIL-based instructions, and the control group received conventional lecture-based contact teaching for the whole course. The intervention group received 25 inquiry-based

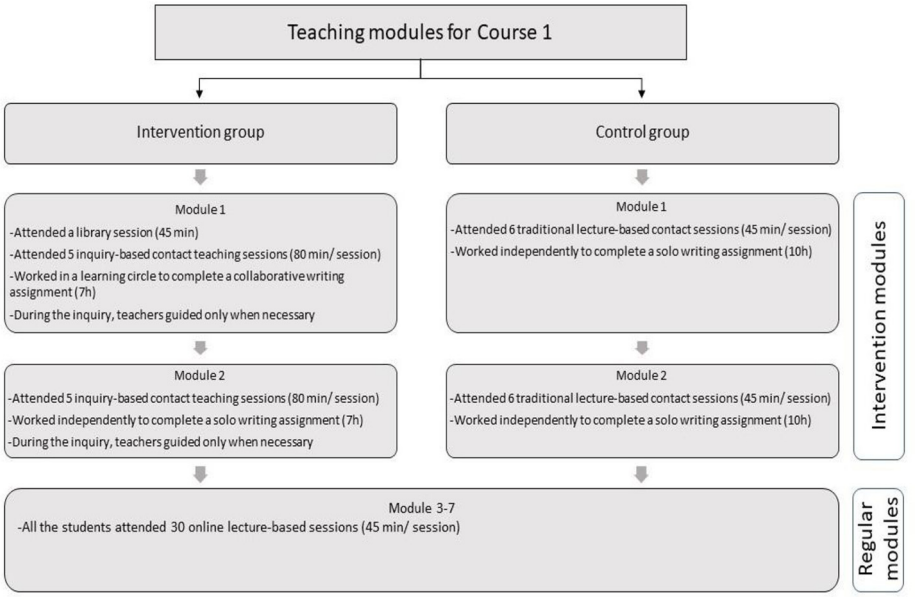

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Figure 1. Teaching modules for Course 1

contact teaching sessions (80 min/session) and completed five collaborative writing assignments for the course. Likewise, in Course 1, the group was divided into nine learning circles, but the circles were newly formed. The control group attended 30 lecture-based instructions (45 min/session) and completed 5 solo writing assignments. The intervention group spent approximately 68 h, and the control group spent approximately 72 h on the course (see Figure 2).

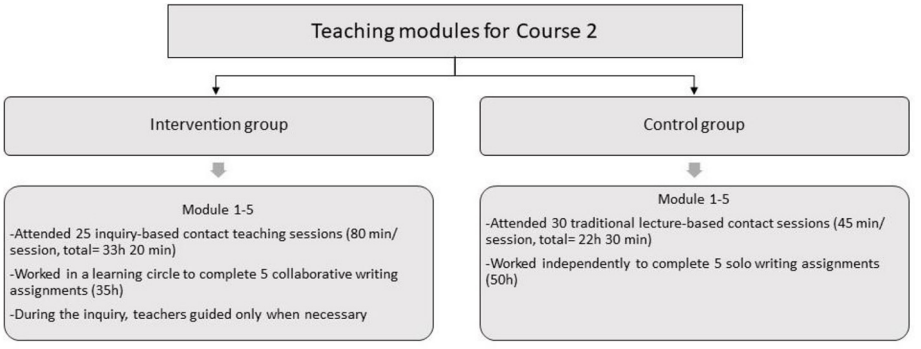

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Figure 2. Teaching modules for course 2

4.3 Instruments

One of the critical tasks in IL intervention is to select the assessment method that precisely measures students' IL competences as well as the effectiveness of the intervention. Knight (2006) categorised IL assessment methods as traditional and authentic. Traditional assessments, such as tests, examine what students know, whereas authentic assessments, such as writing assignments and performance-based assignments, measure how students apply their knowledge in practice. Some researchers (e.g. Beile, 2007; Mackey and Jacobson, 2007; Rockman, 2002) recommended the use of multiple assessment methods, including knowledge tests (quantitative) and performance-based assessments (qualitative). Only a few studies measured both IL knowledge and IL skills to examine the intervention's effectiveness (Mackey and Jacobson, 2007).

Students' feedback (Asplund *et al.*, 2013; Xiao and Traboulay, 2008), self-efficacy (Bakermans and Plotke, 2018; Hulseberg and Versluis, 2017), completed tasks (Adams *et al.*, 2016), pre- and post-activity assessment (Freeman and Lynd-Balta, 2010) and course scores (Johnson-Grau *et al.*, 2016) were used as the evaluation methods of the interventions. Students' IL knowledge (Hossain and Sormunen, 2023; Hulseberg and Versluis, 2017), IL skills (Borchardt *et al.*, 2019), critical thinking skills (Adams *et al.*, 2016) and understanding of the research process (Adams *et al.*, 2016) and value of IL in academic work (Asplund *et al.*, 2013) were improved through embedded IL instructions. Studies found contextualisation as one of the critical characteristics of successful IL integration (Freeman and Lynd-Balta, 2010; Wang, 2011). Wang (2011) argued that IL needs must be contextualised with the course content, learning activities, assignments and assessments.

4.3.1 Information literacy knowledge assessment tool. An information literacy knowledge assessment tool (ILKAT) was developed to examine the IL knowledge of university students applying the ACRL framework (ACRL, 2016). The ILKAT includes 14 multiple-choice questions. All the questions were mandatory to complete the test. The questions can be categorised into three knowledge domains: *searching and gathering online information* (items 1–5), *evaluating online information* (items 6–10) and *understanding the value of information* (items 11–14).

4.3.2 Information literacy skills assessment tool. A performance-based IL assessment tool was designed based on the ACRL framework (ACRL, 2016) to assess the IL skills of university students in developing countries. The information literacy skills assessment tool (ILSAT) includes five tasks that can be categorised into three groups: *searching and gathering online information* (items 1–2), *evaluating online information* (items 3–4) and *creating new knowledge* and *understanding the value of information* (item 5).

4.4 Data collection

All the LIS bachelor first-year first-semester students (n = 76) participated in the IL knowledge pre-test using the ILKAT and the IL skills pre-test using the ILSAT. Students were randomly selected and divided into two groups, i.e. green and red, for the IL knowledge and IL skills pre-tests. The green group participated in the IL knowledge pre-test and IL skills pre-test with the blue version of the ILKAT and ILSAT, and the red group participated with the white version of the ILKAT and ILSAT. Based on students' scores in the IL knowledge pre-test, both the green and red groups were ranked separately and divided into odds and evens. The odds from both the green and red groups were merged as the "intervention group". Similarly, the evens of both groups were allocated into the "control group". Because the division of students into the intervention and control groups was based on their scores in the IL knowledge pre-test, the groups were balanced regarding their IL knowledge.

There was no research ethics committee at the University of Rajshahi where the intervention took place. The authors obtained permission from the Chairman (head) of the

LIS school and used only the course grades for the intervention courses. The researchers obtained consent from the participants to use their pre-test and post-test scores and course grades for this study. They were assured that their personal information would not be disclosed and that the collected data would only be used for research purposes.

After attending the first GIIL-based course in their first year first semester, the university halted contact teaching for about two years due to the COVID-19 pandemic. The students completed their first year second semester online. So, the teaching intervention needed to be postponed to the next academic semester, i.e. the second year first semester, when the university resumed contact teaching. During this semester, the intervention group attended another GIIL-based course in full, and the control group completed the same course with traditional class lectures. After completing the second intervention course, all the students attended the IL skills post-test with the ILSAT and the IL knowledge post-test with the ILKAT. The instruments used for data collection in this study were administered online but students were required to attend the tests in the school's computer laboratory.

The LIS students earned 20% of their course credits through in-course assessments, encompassing group works, presentations, writing assignments, class tests, etc. They had to attend a semester final written examination for the course to earn the remaining 80% of their course credits. The course teacher(s) was free to use any assessment method for the in-course assessment. Thus, students' IL knowledge and IL skills were tested as part of their in-course assessment, and their content learning was measured through the course grades they achieved from the final written examination (see Figure 3).

4.5 Data analyses

All the data collected for this study were analysed using Statistical Package for the Social Sciences (SPSS) (version 27). One-way analysis of covariances (ANCOVAs) were conducted to examine the differences between the intervention and the control groups in the IL skills and IL knowledge post-tests. ANCOVA, a method we chose for its appropriateness to our study, allows us to measure the differences between groups while controlling an additional variable (called covariate). The covariate is a variable that we suspect may influence the results of the dependent variable (Pallant, 2010). In educational research, ANOVA and repeated measures ANOVA are commonly used methods to analyse the changes from pre-test to post-test. These analyses are often inappropriate. An ANCOVA on post-test test scores provides more appropriate and informative results because it keeps the pre-test scores as covariate (Dugard and Todman, 1995).

Independent sample *t*-tests were performed to identify group differences in the IL skills pre-test and IL knowledge pre-test. Independent sample *t*-tests were carried out to test whether there were any differences between the intervention and the control groups regarding their grade points (GP) from the intervention courses. Independent sample *t*-test compares the mean scores on some continuous variables for two groups and determines whether there is statistical evidence that the groups' mean scores are statistically different (Field, 2018; Pallant, 2010). Pearson's correlation tests were conducted to see the relationships between IL knowledge and IL skills. Pearson's correlation test describes the linear relationship between two continuous variables (Pallant, 2010).

5. Results

The present study aims to develop a novel pedagogical practice for IL teaching and learning in a LIS school and evaluate it to determine whether students benefit from this approach. The study also intends to measure whether there are associations between students' IL knowledge and IL skills.

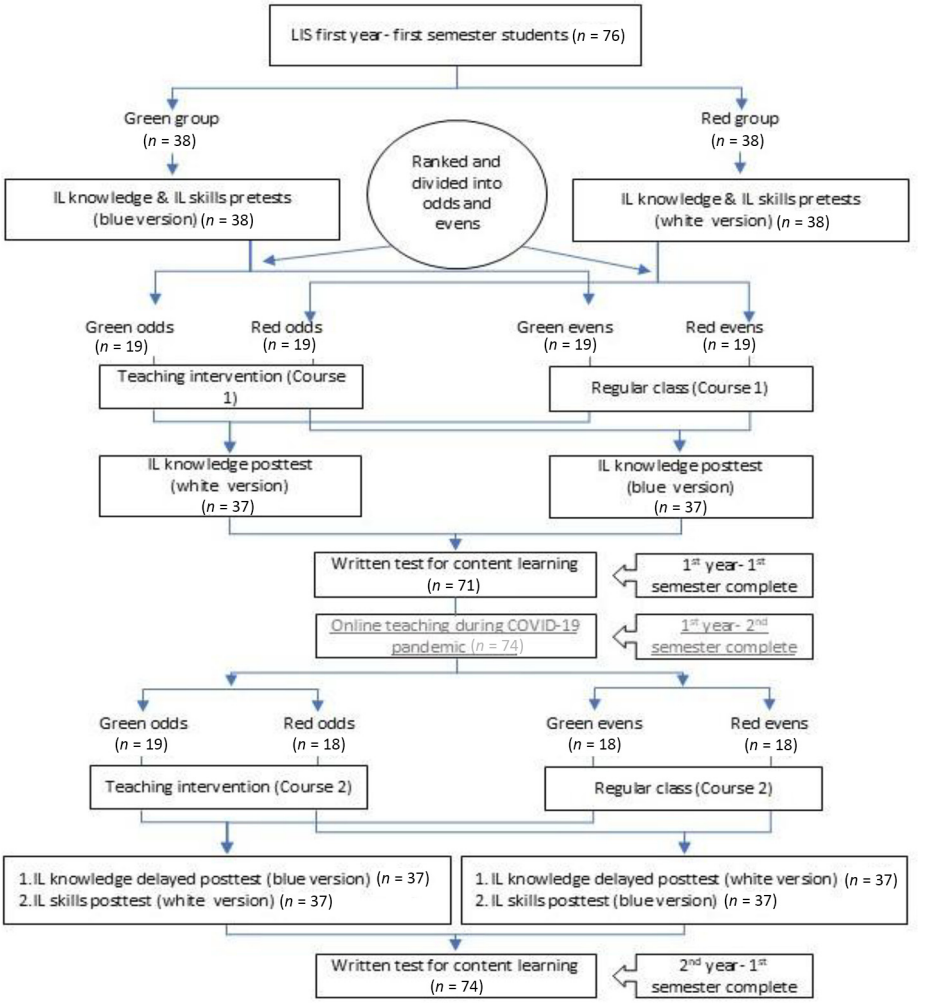

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Figure 3. Data collection diagram

5.1 Information literacy knowledge

Students' IL knowledge was examined before and after the teaching intervention to determine if learners' IL knowledge improved by participating in the new pedagogical practice. In the IL knowledge post-test, the intervention group scored higher than the control group i*n information searching and gathering* [$F = 10.47$, $p = 0.002$, partial $\eta^2 = 0.135$]. The control group scored higher than the intervention group i*n evaluating online information* [$F = 4.33$, $p = 0.041$, partial $\eta^2 = 061$] (Table 1). The effect size was medium in both subdomains (partial eta squared threshold: small: 0.01; medium: 0.06; large: 0.138; see Cohen, 2013, p. 22; Pallant, 2010, p. 210).

Table 1. IL knowledge test scores in pre-test and post-test

	Group difference Intervention group (n = 35), Control group (n = 35)								
	Pre-test				Post-test				
	Means (SD)		t-test		Means (SD)		ANCOVA		
Items	Intervention	Control	t	p	Intervention	Control	F	p	η_p^2
Overall score in IL knowledge tests	2.51 (0.910)	2.61 (0.708)	−0.523	0.602	3.62 (0.799)	3.52 (0.655)	0.617	0.435	0.009
Information searching and gathering	2.40 (1.034)	2.40 (0.976)	0.000	1.000	3.86 (0.912)	3.11 (1.078)	10.47	*0.002*	0.135
Evaluating online information	3.03 (1.294)	3.43 (0.948)	−1.475	0.145	3.40 (1.035)	3.91 (0.781)	4.33	*0.041*	0.061
Understanding the value of information	2.00 (1.015)	1.86 (1.066)	0.574	0.568	3.61 (1.203)	3.54 (1.027)	0.017	0.897	0.000

Source: Authors' own work

In the IL knowledge pre-test, the female students' score was higher i*n overall IL knowledge test* [$t = -2.14$, $p = 0.036$] and *information searching and gathering* [$t = -2.67$, $p = 0.010$]. However, no gender differences were found in overall scores in IL knowledge post-test and any of its subdomains.

5.2 Information literacy skills

The study examined whether students' IL skills improved by participating in the newly developed pedagogical practice. In the IL skills post-test, the intervention group scored higher than the control group in overall IL skills and all the subdomains of IL skills. The intervention group scored significantly higher than the control group in overall scores in IL skills [$F = 43.64$, $p = >0.001$, partial $\eta^2 = 0.38$, 1] and all of its subdomains, *information searching and gathering* [$F = 15.53$, $p = >0.001$, partial $\eta^2 = 0.179$], *evaluating online information* [$F = 20.41$, $p = >0.001$, partial $\eta^2 = 0.223$], *source-based writing* [$F = 22.44$, $p = >0.001$, partial $\eta^2 = 0.240$], and *understanding value of information* [$F = 21.31$, $p = >0.001$, partial $\eta^2 = 0.179$] (Table 2). The effect size was large (see Cohen, 2013, p. 22; Pallant, 2010, p. 210). In both IL skills pre-test and post-test, no gender differences were found in overall scores or all the subdomains of IL skills.

5.3 Content learning

The results show that in the first intervention course, no difference was found in content knowledge learning between the intervention and control group (Table 3). However, from the second intervention course, the intervention group (M = 3.22) learned the course contents more intensely than the control group (M = 3.00), $t(72) = 2.665$, $p = >0.05$. The effect size, measured by Cohen's *d*, was $d = 0.63$, indicating a medium effect (small effect: 0.2; medium effect: 05; large effect: 0.8, see Cohen, 2013).

5.4 Relationships between information literacy knowledge and information literacy skills

A Pearson's correlation test revealed relations between students' IL knowledge and IL skills. The study revealed that students' *overall IL knowledge* was related to their *overall IL skills*, $r = 0.361$ ($p < 0.01$). Their *overall IL knowledge* was also associated with their *skills in evaluating online information*, $r = 0.290$ ($p < 0.05$), *skills in source-based writing*, $r = 0.366$ ($p < 0.01$) and *skills in understanding value of information*, $r = 0.325$ ($p < 0.01$).

I*n information searching and gathering* and *evaluating online information* subdomains, students' knowledge and skills were not related. *Understanding value of information* was the only subdomain where an association was found between their knowledge and skills, $r = 0.271$ ($p < 0.05$) (Table 4). No correlation was found between students' pre-test scores in IL knowledge and IL skills.

6. Discussion

The study aimed to integrate IL instructions into an LIS school's general course curriculum and evaluate the effectiveness of a novel pedagogical practice, "GIIL", through a long-term teaching intervention. A key distinction of this study in the LIS domain is its comprehensive approach, measuring students' learning outcomes in both IL knowledge and IL skills. Unlike previous interventions that focused on enhancing students' IT knowledge (Lamb, 2017) or IL knowledge (Hossain and Sormunen, 2023; Pinto and Fernández-Pascual, 2019), this study provides a holistic view of students' IL development.

Our empirical findings suggest that the guided inquiry-based pedagogical practice was particularly effective in improving students' IL skills. Learning outcomes were consistently

Table 2. IL skills test scores in pre-test and post-test

	Group difference Intervention group (n = 37), Control group (n = 37)								
	Pre-test				Post-test				
	Means (SD)		t-test		Means (SD)		ANCOVA		
Items	Intervention	Control	t	p	Intervention	Control	F	p	η_p^2
Overall score in IL performance tests	1.04 (0.385)	1.09 (0.447)	−0.52	0.603	2.35 (0.639)	1.53 (0.522)	43.64	*>0.001*	0.381
Information searching and gathering	1.35 (0.756)	1.43 (0.841)	−0.40	0.691	3.05 (0.791)	2.41 (0.633)	15.53	*>0.001*	0.179
Evaluating online information	1.29 (0.650)	1.40 (0.673)	−0.70	0.484	2.61 (0.824)	1.61 (1.024)	20.41	*>0.001*	0.223
Source-based writing	0.93 (0.419)	1.05 (0.400)	−1.28	0.206	1.95 (0.868)	1.14 (0.620)	22.44	*>0.001*	0.240
Understanding the value of information	0.57 (0.603)	0.47 (0.536)	0.76	0.448	1.77 (0.861)	0.97 (0.578)	21.31	*>0.001*	0.231

Source: Authors' own work

Table 3. Course content learning in the intervention and control groups

Items	Total	Intervention	Control	*t*	*p*	Cohen's *d*
GP Mean (SD) for the intervening course 1 (*n* = 71)	3.26 (0.366)	3.32 (0.335) (*n* = 35)	3.19 (0.388) (*n* = 36)	1.474	0.145	0.36
GP Mean (SD) for the intervening course 2 (*n* = 74)	3.11 (0.363)	3.22 (0.334) (*n*= 37)	3.00 (0.363) (*n* = 37)	2.665	0.010	0.63

Source: Authors' own work

good in all components of the measured IL skills: *information searching and gathering*, *evaluating online information*, *source-based writing* and *understanding the value of information*. The students in the intervention group worked actively on information-intensive learning assignments both individually and in small groups. IL skills are knowledge work competences that are difficult to learn without active and intensive practice on realistic assignments (see, e.g. Muukkonen *et al*., 2017). The findings align with those of Squibb and Mikkelsen (2016), who found that university students' skills in using suitable sources and academic writing improved by participating in embedded IL courses.

The results regarding learning outcomes in IL knowledge were less promising. We observed only sporadic improvement in students' knowledge, particularly i*n information searching and gathering*. The reasons for this weak creation of IL knowledge in the intervention are clear: IL knowledge was not a formal but embedded learning objective of the intervened courses. No explicit instruction was given to increase students' IL knowledge. Instead, the focus was on guiding students in searching, gathering, evaluating and using online information in their learning assignments; an uncontrolled intervening factor likely affected the post-test results. After the pre-test, all students attended a compulsory online course on referencing and citation management, which may have diluted the effect of the intervention; and the instrument used to measure knowledge learning outcomes was too generic, as the specific IL knowledge contents to be learned were not explicitly specified.

The guided inquiry-based pedagogical practice was also helpful in developing learners' knowledge of the course content. In the first course, no difference was found in content learning, and students in the intervention group expressed confusion in adopting inquiry-based assignments. They were not used to them. However, the long-term benefits were obvious. The intervention group students gathered learning experience with a new pedagogical practice and benefited from the second intervening course (long-term effect). The students learned their course contents through online inquiry and essay writing with the support of the course teacher(s). They gathered and explored multiple sources of online information on their selected topic, evaluated them for writing essays, discussed the topics in their small learning circle, and wrote the essay collaboratively. The process led them to learn the course content more in depth. The findings are in line with some previous studies. Inquiry-based pedagogy was found to be more effective than traditional lecture-based teaching also in science (Idul and Caro, 2022), social work (Archer-Kuhn *et al*., 2020) and language (Alameddine and Ahwal, 2016).

The results concerning the relationship between students' IL knowledge and IL skills were complex and confusing. Students' *overall IL knowledge* correlated with their *overall IL skills* and its subdomains, except with *information searching and gathering*. However, their knowledge and skills, in particular, IL subdomains, were not related; for example, students' *knowledge of information searching and gathering* was not associated with their *skills in information searching and gathering*. Thus, no conclusive findings were achieved about the

Table 4. Correlations between students' IL knowledge (post-test) and IL skills (post-test) (n = 70)

	Information literacy skills				
Information literacy knowledge	Overall IL skills	Skills in information searching and gathering	Skills in evaluating online information	Skills in source-based writing	Skills in understanding value of information
1. Overall IL knowledge	0.361**	0.167	0.290*	0.366**	0.325**
2. Knowledge of information searching and gathering	0.371**	0.230	0.215	0.384**	0.380**
3. Knowledge of evaluating online information	0.093	−0.052	0.139	0.165	0.019
4. Knowledge of understanding value of information	0.285*	0.163	0.260*	0.206	0.271*

Notes: **Correlation is significant at the 0.01 level (two-tailed); *correlation is significant at the 0.05 level (two-tailed)
Source: Authors' own work

associations between IL knowledge and skills. As discussed above, students did not receive direct instruction to increase IL knowledge but guidance to accomplish their assigned tasks requiring practicing IL skills. Individual experiences in practicing IL skills might lead students to enhance different aspects of IL knowledge. Thus, it seems that the generic instrument did not consistently measure learning outcomes in subdomains of IL knowledge. The summary measure – *overall IL knowledge* – balanced the differences in learning outcomes across the subdomains and indicated some relationships.

7. Conclusion

Most IL instruction research has been conducted in technologically advanced countries. Our study took place in a developing country where students have limited access to technological and educational resources. The problems of the digital and educational divide might be more substantial among incoming university students. In Bangladesh, students do not receive formal training to improve their IL competences at their primary, secondary, higher secondary or university level. Our point of departure in this study was that academic librarians, especially university library professionals, have a huge opportunity and responsibility to help students develop their IL competences.

University librarians in Bangladesh mostly graduated from the three LIS schools of public universities in Bangladesh. The University of Rajshahi is one of those three public universities where this research was carried out. LIS students receive library-centred IL training in their schools but do not have opportunities for pedagogy training. The guided inquiry-based pedagogical practice "GIIL" helps LIS students develop their IL knowledge and skills through regular courses and simultaneously learn about a learner-centred pedagogical practice. Their learning about the pedagogical practice will increase their self-efficacy and motivation to provide IL instructions as library professionals. On the contrary, this research can motivate other LIS teachers in Bangladesh and other countries to embed IL instructions in their regular courses through the GIIL. They will not require additional resources or university approval for such interventions.

This research will pave the way for researchers, librarians and academics in LIS schools of other universities in developing countries to conduct IL teaching interventions. The detailed intervention process and the instruments for the pre-test and post-test were published in our previous paper (Hossain and Sormunen, 2023) so that future researchers can conduct similar studies. A qualitative study on the effectiveness of the guided inquiry-based pedagogical practice in LIS schools will give us a more rigorous insight into this area of research. Other interesting avenues for future research might be to explore the key factors to improve IL knowledge through interventions and why students' IL knowledge is not reflected in their IL skills or vice versa.

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Corresponding author
Md Arman Hossain can be contacted at: armanhossain.isl@gmail.com